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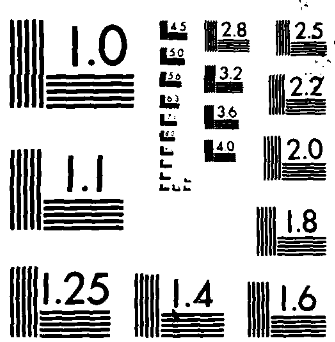
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AN ANALYSIS OF PILOT TRAINING
FOR F-16 IMPLEMENTAION
BY THE REPUBLIC OF KOREA AIR FORCE

THESIS

YOUNG JONG, LEE

AFIT/GOR/OS/85D-12

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AN ANALYSIS OF PILOT TRAINING
FOR F-16 IMPLEMENTATION
BY THE REPUBLIC OF KOREA AIR FORCE

THESIS

Presented to the Faculty of the School of Engineering
of the Air Force Institute of Technology
Air University
In Partial Fulfillment of the
Requirements for the Degree of
Master of Science in Operations Research

Yong Jong, Lee
Major, ROKAF

November 1985

Preface

This study was intended to provide insight into the pilot training for the F-16 implementation by the Republic of Korea Air Force (ROKAF) and to identify significant factors affecting the training process.

A simulation model of the F-16 pilot training system was developed using a SLAM network with FORTRAN subroutines. This model transforms student pilots and upgrading instructor pilots into F-16 pilots and instructors using limited resources such as instructors, number and type of aircraft, and airwork areas based on requirements of the training syllabus.

In the development of this study, I am deeply indebted to my faculty advisors, Major William F. Rowell and Lieutenant Colonel Palmer W. Smith, for their special guidance and advice. Also I sincerely appreciate Lieutenant Colonel Sung Il, Kim, a ROKAF representative for the Peace Bridge Program, in ASD/YPXI USAF. Without his cooperation and assistance, this analysis would not have been possible. Finally, I would like to thank my wife, Yong Hee, for her loving support, patience, and encouragement through this study.

Young Jong, Lee

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Abstract

Insight for the pilot training for the F-16 implementation for the Republic of Korea Air Force is provided, and statistically significant factors affecting the training process are identified. To analyze the F-16 pilot training system of the transition period, a simulation model of the training system is built using a SLAM network with FORTRAN subroutines. Four factors of interest to the planners are investigated from a baseline to an expected value with respect to the average days to complete total training and the average days to complete transition and upgrading instructor pilot training used as measures of effectiveness. Several factors and interactions are significant for each response variable. The most significant finding is that increasing the number of student pilots per class from six to seven reduces the number of classes required from eight to seven, saving about three months. This increased student load can be accomplished within allocated resources.

Any change to the F-16 implementation plan can be analyzed prudently with this model. This model is flexible to different scenarios and prodution goals by changing input variables. The model can be used as a general one for

analyzing a transition period of any F-16 implementation, using limited resources on a predetermined syllabus schedule with random variables.

An Analysis of Pilot Training

for F-16 Implementation

by the Republic of Korea Air Force

I. Introduction

Background

The Republic of Korea (R.O.K.) decided to strengthen its air power and modernize its Air Force to deter a North Korean invasion. Many studies have been done to determine the type and number of aircraft needed for deterrence. The studies conclude that the F-16 would be the most suitable one for the Korean situation. The F-16 will hence take the most important role in the R.O.K. Air Force (ROKAF) Modernization Program; it will be a critical component for peace in the Korean peninsula.

The Peace Bridge Program (PBP) for the procurement of the F-16 started 1 December 1981 with the signature of the Letter of Acceptance (LOA). Under this agreement, the F-16 aircraft will begin production deliveries in February 1986 and continue until January 1989. The first in-country delivery will be in April 1986 and continue until February 1989.

Many people concerned with this program have developed a Program Management Plan (PMP) which covers all aspects of

the Peace Bridge Program from the LOA to operational readiness. The PMP is the basic instruction which ties all actions together to ensure an efficient process of sale and transition to the ROKAF. These actions include contractor support, training of all personnel in 17 specialties, logistics support, initial spares, base preparation, and related areas.

The adoption of a mility fighter aircraft into a country's Air Force requires many actions to be done. Implementation can be divided into a procurement phase, an initial transition phase, and a fully operational phase. The actions for procuring the F-16 have been completed already and production of the first aircraft has already begun. From an operational aspect, the initial transitioning phase is much more important and requires systematic and formal detailed analysis.

Problem Statement

The ROKAF desires the F-16 fighter squadron to be operationally ready for all missions by the required date. It is concerned about problems which may affect the implementation and time to operational readiness and how these problems can be overcome or minimized for an effective and efficient transition.

A key element in the total program is the training of ROKAF pilots to fly the F-16. Many factors may affect the timely training of pilots. These include:

1. workload in the training wing,
2. monthly weather cancellation rate,
3. aircraft available for training,
4. F-16 delivery rate to Korea,
5. student pilot attrition,
6. syllabus of instruction,
7. number of instructor pilots,
8. number of hours of academic training,
9. students per class,
10. number of sorties required for qualifying,
11. student-to-aircraft ratio,
12. daylight hours per month,
13. days to transition new instructor pilots,
14. number of sorties to transition an instructor pilot,
15. number of pilots required for operational readiness,
16. starting date of training,
17. training effectiveness.

Research Questions

How will these various training factors affect the ability of the ROKAF to produce combat ready F-16 pilots to meet the desired date for full operational readiness? What actions are most likely to increase the probability of meeting the desired operational capability date?

Objectives

This research focuses only on the pilot training aspects of the PBP and the F-16 implementation plan for the ROKAF. The overall objective of this research is to:

1. identify those factors which significantly affect the time required to produce the number of F-16 pilots for full operational readiness in Korea,

2. identify those factors which significantly affect the average number of days to graduate a class.

The accomplishment of these objectives will provide valuable information to key ROKAF decision makers to help minimize or avert problems in the pilot training portion of the PBP and help to ensure the highest possible probability for successfully providing the required F-16 pilots.

Scope

The F-16 implementation plan for the ROKAF and the PBP provide general guide lines for operational plans, logistics, personnel, and so on. This research will focus on the pilot training of the operational aspects of the plan. The ROKAF HQ DCS/O will analyze the portion of the operations to implement the F-16 successfully.

Furthermore, The effort of this research centers on the initial transition phase, which can be defined as the time period between the first and the last aircraft delivery.

This study will focus on the time frame of the first F-16 pilot training in Korea until the last class during the transition.

Measures of Effectiveness

The measures of effectiveness for this study will be the average number of days to generate the number of pilots required for operational readiness for each F-16 squadron and the average number of days to graduate a class. These measures will show how the factors given in the problem statement affect the transition. And these will vary depending upon the change of the input variables. Those factors significantly affecting these measures of effectiveness will be identified for further consideration.

Study Approach

The overall study approach for accomplishing the objectives of this study is to :

1. Understand the pilot training program plan associated with the F-16 implementation by the ROKAF.

2. Analyze the structure of the pilot training system.

3. Construct a flow diagram of the pilot training program plan and identify key factors, potential bottlenecks and problem areas.

4. Determine required data and assumptions.

5. Collect data and develop probability distributions.

6. Build a simulation model which will represent the structure of the pilot training system.

7. Verify and validate the model by insuring that the computer code performs as desired.

8. Analyze the experimental design for the factor evaluation and identify those factors which significantly affect the training of the F-16 pilots.

9. Simulate alternative approaches to overcoming problems discovered.

Understanding the Training Program. The F-16 implementation plan for the ROKAF gives the overall program guidance, including the first portion of flight transition training. A more comprehensive F-16 pilot training plan has been studied in the ROKAF Headquarters (HQ) Deputy Chief of Staff for Operations (DCS/O). However, this plan does not contain the details required to model the F-16 pilot training.

The above information can be supplemented by incorporating the judgement of planners at HQ ROKAF and at USAF Aeronautical Systems Division (ASD/ YPXI) and at USAF International Logistic Command (ILC). Assumptions on the key issues will be based upon knowledge and experience of personnel in the Peace Bridge Program.

Understanding Training System Structure. The pilot training program, the existing USAF F-16 pilot training system, and the judgement of planners (HQ ROKAF, USAF/ASD/YPXI, and USAF/ILC) will assist in defining the structure of the F-16 pilot training plan and the relationships among the system variables. Factors which are initially identified as affecting timely training of pilots will form the basis for identifying necessary data to be gathered. The following data was gathered from the HQ ROKAF DCS/O and the USAF/ASD/ YPXI or USAF/ILC: workload in the training wing, monthly weather cancellation rate, daylight hours per month, aircraft available for training, aircraft abort rate and attrition rate, F-16 delivery rate to ROKAF, number of sorties for transition of pilot and upgrading instructor pilot (UIP), number of student pilots (SP) and IPs per class, number of hours of academic training, student to aircraft ratio, number of pilots required for operational readiness, and starting date of training.

Model. The structure of the training system is translated into a SLAM simulation model and analyzed using experimental design. Simulation appears to be an appropriate tool because the F-16 pilot training is a lengthy, complex process involving a large number of random events. The result of simulation provides the information

about what may happen, which variables are most important, and how variables interact.

Verification and Validation. The pilot training model must represent the system well enough to accurately answer the basic questions described above. The model is constructed especially for the ROKAF F-16 situation and verified fully. But this new F-16 implementation by the ROKAF lacks complete historical data. Because of the lack of ROKAF historical data, validation is difficult, but is attempted. Values assumed for the variables lacking historical data are used for checking the model for reasonable output and for sensitivity analysis.

Identifying Significant Factors. Within the relevant range of the variables of interest, high and low values are used for inputs for identifying the significant factors affecting the training of the F-16. The necessary combinations of variables and the number of replications are determined using experimental design.

Analysis of variance (ANOVA) is used to identify the significant factors. Sensitivity analysis is performed for the input variables and input distributions.

Summary

The implementation of the F-16 by the ROKAF, which will be a most important part in deterring a North Korea invasion, requires many things to be done. The ROKAF desires the F-16 squadron to be operationally ready for all missions as soon as possible during the initial transition phase.

This study is intended to identify how various factors affect the F-16 pilot training. The measures of effectiveness of the training system model are the days needed to produce the required number of F-16 pilots and the average days to graduate a class. Simulation is used as a tool to produce these measures of effectiveness.

The overall steps taken in this study are: 1. understanding the training system, 2. analyzing the structure of the training system, 3. modeling, 4. verifying and validating the model, and 5. identifying significant factors.

II. Literature Review

Introduction

Several sources of information are needed to develop the F-16 pilot training model for Korea. Before discussing the techniques, it is important to review the plans and key sources for the F-16 implementation by the ROKAF and the methods used in past studies of similar pilot training.

The basic requirements for F-16 pilot training phase can be found in Peace Bridge Program Management documents. These related training plans are reviewed first, followed by the F-16 Implementation Plan. The syllabus of instruction for the F-16 pilot training is key to this study and is discussed in detail. The PBPMP, related training plans, and the syllabus of training are all the key sources for this study. Finally, studies which have looked at USAF pilot training are investigated for methodology and approaches.

Peace Bridge Program Management Documents

Peace Bridge Program Management Plan (PBPMP) (8). The PBPMP provides guidelines for the implementation of the F-16 acquisition program for the ROKAF. The PBPMP contains requirements, responsibili-ties, program management milestones, logistic support, maintenance, training, aircraft delivery, and operational concept which are needed to successfully complete the ROKAF F-16 program. It

provides the primary guidance for pilot training for F-16 implementation by the ROKAF. The program summary outlines an initial overview of general description and concept for the ROKAF F-16 program. The summary states that initial pilot training will be conducted in the CONUS and in the ROK. The major tasks of ROKAF representatives are described in the organization and responsibility section. The starting date of flight training in CONUS and the aircraft delivery are found in the program management schedule with other event's milestones.

The PBPMP outlines the recommended minimum training program for the ROKAF personnel for pilot training and technical training. For pilot and maintenance training, the ROKAF personnel will be trained through a cadre approach. The objective of pilot training is defined as providing F-16C/D flight qualification and intructor training for eight ROKAF pilots. The CONUS training of the two ROKAF pilots will be completed by March 1986. The top-off training will be taken in the ROK. The PBPMP also contains schedules about courses and typical course contents. (8:11-1; 11-31)

Program Management Review (PMR) (9). The minutes of PMRs formally document management review, logistics, training, action item status, and discussions. The latest review is the fourth Peace Bridge PMR convened October, 1984 at HQ/ ROKAF, Seoul, Korea. As a directive outline, it provides informations on changes to the basic PBPMP.

The training status briefed at that meeting shows more information of technical training and pilot training status. A proposed tentative course outline of the F-16 transition course and Instructor Pilot (IP) course is documented in the training section. The transition training course takes 22 sorties, 28.2 flying hours, and 225 academic hours. The upgrading instructor pilot course is completed with 16 sorties and 38 academic hours.

The initial technical training of the ROKAF aircraft technicians consists of USAF technical training and contractor technical training with completion by March 1986. After returning to Korea, these technicians will support the F-16 aircraft operation and develop further in-country technical training for additional ROKAF personnel. Special efforts are being made to ensure the aircraft can be supported fully at the initiation of training in Korea. (9:33-34; 199-230)

<u>F-16 Implementation Plan (12)</u>. The integrated effort of the ROKAF HQ, ensuring the successful F-16 implementation into ROKAF is contained in the F-16 Implementation Plan. This outlines all aspects of transition, including an orderly conversion and a tentative sequence of events. The plan contains objectives, assumptions, concept of operations for operations, plans, logistics support, personnel, intelligence area, and inspector general responsibilities. ROKAF HQ DCS/O is responsible for the plan.

Only the operational aspects of the plan are within the scope of this research. The plan states that the first transition class of F-16 student pilots will enter the course in August 1986. Thereafter, each class will start the transition training every three months until all the pilots required for operational readiness are trained.

There will be certain criteria for selecting the student pilots such as total flying hours and the level of experience. After the first class finishes the transition training, some of them will be selected and upgraded to instructor pilots. There will be no upgrading instructor pilots from the first class. From the second class on, two pilots are selected from the previous transition class for upgrading to instructor pilots. Upgrading instructor pilot training will start at the same time as transition training, except for the first and the last transition class.

During the training period, pilots who finish the transition training, but are not selected for upgrade instructor pilot training, will share the available aircraft with student pilots in order to meet minimum requirments and increase proficiency. Therefore, the student pilots and the instructor upgrade training will compete for the same aircraft resources.

Syllabi of Training (11)

The ROKAF HQ has not developed a detail syllabi for a transition training course and a instructor pilot upgrade course. The first two pilots trained in CONUS will be responsible for developing several syllabi in detail after they return to Korea. In this research, the USAF training syllabi is used for determining the required days of transition and upgrading because it probably will be used as the base transition syllabi for the ROKAF syllabi.

The USAF transition training course syllabus provide overall training guidance and prescribes the amount of instruction normally required for transition training of student pilots. It contains information about course accounting, course management, academic training, aircrew training devices, and flying training.

The course entry prerequisites, the status upon completion, the course inventory, and the aircraft configuration are described in the course accounting section. The graduates are qualified to fly F-16C/D aircraft. Selected graduates will enter instructor pilot upgrade course.

The course management section explains the training standards, the grading criteria, the general instructions, the course map, and the management flow chart. The course map indicates that before a certain type of instruction starts, a student pilot must have successfully completed all prerequisites, both flying sorties and academics.

The academic training section describes the detailed information of each lecture, seminar, and tests. The aircrew training devices are an egress procedure trainer, a cockpit familiarization trainer, a static aircraft, and an advanced simulator. Other trainers can be substituted for static aircraft.

The flying training section is divided into three phases: Conversion, Air-to-Air, and Air-to-Surface. The special instructions, mission descriptions, and mission objectives are covered for each phase and for each mission. Missions requiring an F-16C may be replaced with those requiring an F-16D, if the mission is flown effectively and no F-16C's are available at all. During the course a student may fly as much as four additional sorties if mission standards are not attained. For optional flying experience, a student may observe the instructor missions by riding in the rear cockpit. The detail mission descriptions are provided in the flying training section.

The structure of the syllabus of the instructor pilot upgrade training course describes the overall training guidance required for upgrading instructor pilot. The graduates will be prepared to instruct all F-16 formal courses.

Related Studies

The following studies have similar characteristics in terms of methodology, system structure, and input variables to this research.

One of these studies was conducted by Captain John P. Wood as a graduate student at the Air Force Institute of Technology(AFIT). He built a model that determines a scheduled sortie rate in order to obtain a predetermined training level for one F-4E squadron. By analyzing squadron structure, scheduled flight operations, scheduled pilot operations, and time distributiions of each flight operation, a structural model was first developed. An F-4E squadron's operations were modeled with a Q-GERT network simulation program. Finally, an interactive computer model capable of determining a minimum scheduled sortie rate was developed to allow a predetermined Graduated Combat Capability level to be achieved. The experimental design included the structural, functional, and experimental modes.

But his research was limited only to determining revised sortie rates. This study did not treat the aircraft and pilots as resources. For the case of tracking aircraft as resources, daily operations would be highly dependent upon such random variates as ground aborts, ground delays, and maintenance turnaround time. (14)

The other related studies have been done on the USAF undergraduate pilot training program. The first one is a

thesis written by Major Seth V. Jensen which analyzed the pilot conversion process for the USAF T-46 aircraft. The study used the average values for all data taken from the T-46 Master Implementation Plan. By using hand calculations his ability to conduct an entire analysis was limited. His use of average values made it impossible to handle the random nature of factors and sensitivity analysis. (5)

An AFIT master's thesis by Major Jack R. Dickinson and Captain Glenn E. Moses analyzed the conversion from the T-37 to the T-46 aircraft in undergraduate pilot training in order to provide insight into factors which significantly affect pilot production. Simulation models for T-37 and T-46 aircraft training were developed in that study. They structured the undergraduate training system, T-37 squadron training process, scheduling process, conversion process, variables, and so on. Finally, they performed an experimental design.

A model of the undergraduate pilot training system during the conversion from the T-37 to the T-46 was built using SLAM networks. The model can be used for pilot training with limited resources (instructors, aircraft, area) on a predetermined syllabus, including random variables (weather and maintenance abort).

But, undergraduate pilot training involves a single type of aircraft and relatively constant flying time, the study did not consider the different types of missions as

would be the case in F-16 pilot training. For example, all the missions are not performed with a single airplane. In other words, some missions are conducted with a two-ship formation, which requires two student pilots and two instructor pilots. Thus, their program does not address the F-16 pilot training situation. (2)

The last research effort is an analysis of the specialized undergraduate pilot training (SUPT) program performed by Captain Joseph B. Niemeyer and Captain Michael D. Selva. A simulation model of the SUPT program was developed to determine the ability of the current program design. The research treated the student pilot attrition, weather aborts, and maintenance abort rates as random variates drawn from probability distributions. A conceptual model and mathematical model were translated into a SLAM network model with FORTRAN subroutines. After that, an experimental design was employed and the results analyzed.

The SUPT program design involves the operation of several phases and several bases. By overlooking the random nature of such factors as aircraft turn-around time, aircraft repair time, and the actual flying time, the scheduling process is not same as real-world. (7)

Summary

The PBPMP and PMR provide the basic concepts for the total ROKAF upgrade pilot training program. The combined

efforts of the ROKAF and the USAF are presented in the F-16 Implementation Plan to ensure an effective and successful transition. Since the ROKAF has had no experience in managing the F-16 aircraft, it does not have its own syllabi of instruction as yet. For this reason, the USAF transition training syllabus and upgrading instructor pilot training syllabus were reviewed. The ROKAF has not conducted a formal detailed analysis of the pilot training for the F-16 implementation, because no proper models exist there. A variety of similar efforts, analyzing pilot training in undergraduate pilot training program and an F-4E squadron, appear in theses studied at AFIT. These studies do provide ideas for important features and approaches for this study. However, ignoring the aircraft dependency upon such random variates as ground aborts, ground delays, and not considering the type of mission such as the number and type of aircraft in a mission ,and variable flying time limit somewhat their usefulness for studying changes in system.

III. Model Formulation

Introduction

This chapter discusses the F-16 training environment, including the general structure to be translated into a model. Understanding of the system operation should precede the model construction, since a model is a description of a system. The squadron structure, the training process, and the components and variables are first discussed, followed by a complete description of the model.

System Description

Proposed F-16 Squadron Structure. Before the first transition class of F-16 student pilots begins, an F-16 fighter squadron is created. There is no special training squadron. The transition training is conducted in the F-16 fighter squadron itself. Information on the squadron operations and the framework for the system was obtained from ROKAF, TAC/USAF, and the personal experiences of the author.

The basic structure and operation of the F-16 squadron for this research is the same as any other fighter squadron which already exists in the ROKAF. The squadron starts the transition training with four instructor pilots, two of which are the USAF Mobile Training Teams and six F-16D

aircraft. Eacn class has six transition student pilots, starts every three months and continues until eight classes are completed. The UIP training begins with the second class of transition training, and a total of six classes are trained. Once transition training is completed, the graduates continue flying in order to maintain their skills and to gain more experience as fighter pilots.

The aircraft are delivered every four months. Of the aircraft delivered some are reserved for transition training, and the others are used for pilot training. Hence, as the training progresses and more aircraft are delivered, four F-16Ds and four F-16Cs are reserved for transition and upgrading IP training. When the first training class starts, only six F-16Ds are available. After first F-16Cs' delivery, four F-16Ds and two F-16Cs are used. There will be four F-16Ds and four F-16Cs after second delivery. Once the UIP training is finished, the last transition class will use four F-16Ds and two F-16Cs.

Three airwork areas are allocated for the F-16 pilot training. Only one flight can fly its mission in each area at a time.

Training Process. The general structure of transition training is based upon the USAF transition training syllabus, the PBPMP, and the PMR.

The transition training course academics module summary is as follows (9:220):

Conversion	105 hours
Air to Air	60 hours
Air to Ground	60 hours
Total	225 hours

The transition training flying module is (9:213-217):

Transition	5 sorties	7.0 hours
Intercept	2 sorties	3.0 hours
Basic Fighter Maneuver(BFM)	6 sorties	6.6 hours
Dissimilar/Air Combat Maneuver(D/ACM)	2 sorties	2.0 hours
Surface Attack(SA)	5 sorties	7.0 hours
Surface Attack Tactics(SAT)	2 sorties	2.6 hours
Total	22 sorties	28.2 hours

The upgrading instructor pilot training academics module is (9:225):

Instructional Technique	12.5 hours
Conversion	8.0 hours
Air to Air	10.0 hours
Air to Ground	7.5 hours
Total	38.0 hours

The upgrading instructor pilot training flying module is (9:221-224):

Transition	2 sorties	2.8 hours
Intercept	1 sorties	1.5 hours
BFM	3 sorties	3.0 hours
D/ACM	3 sorties	3.0 hours
SA	4 sorties	5.6 hours
SAT	3 sorties	4.2 hours
Total	16 sorties	20.1 hours

There are prerequisites for each flying sortie in the syllabus. The flying training must follow the proper order of training exactly, and all academic training prerequisites should be completed before a certain module starts. Nineteen days of ground training precede the start of flying training for the transition course and five days of preflight academic training for the UIP course. In addition, each student takes ninety hours of academic training for the transition course and twenty-two hours for the UIP course during each period. After flying training starts, academic training is given for all the students of each class rather than student by student. The maximum amount of academic training per day is eight hours.

Many factors are involved in the scheduling of flight operations. All sorties are scheduled based on weather conditions, daylight hours, airwork areas, available

aircraft, and estimated turn-around time. A student pilot is scheduled to fly during the daylight hours of each duty day.

All sorties are generally scheduled according to the syllabus of instruction. But if a certain type of aircraft is not available, the required aircraft may be replaced with the other type. If a mission consists of two students and only one has not completed the mission, it is replaced with another type mission. For example, there are no F-16Cs available at all during the first training class. In this case, all missions requiring F-16Cs are replaced with the ones using F-16Ds.

A typical training mission is described below. Two hours prior to a flight, the student pilot and the instructor pilot conduct a one and half hour mission briefing. After the briefing they report to their aircraft for preflight checks and start the engine thirty minutes before takeoff. After starting the engine and making ground checks, the flight taxies out to the quick check area where the maintenance crews perform a final inspection. Finally, they fly the mission. The maintenance debriefing is conducted with the ground crew after the flight to document the mission flown and any discrepancies discovered during the operation. The mission is completed with the one-hour pilots' debriefing.

Components and Variables. A review of the squadron structure and the training process identified various components and variables which should be included in a model of the F-16 training system. The system consists of student pilots, instructor pilots, aircraft, training wing workload, and maintenance support. The student pilots are the key elements, and all other components are treated as resources. The daily training process is involved in all of the components described above, and a sortie is generated and completed with these resources. Every component is very important and should be considered to accurately model the F-16 training system.

All the variables in the system come from these components, and those variables which ought to be included in the model are consolidated to some extent with proper judgement and experience. For example, the maintenance complex contains the maintenance crew, logistic support, ground support equipment, and so on. But if all these variables are included in a model, the model would become too big to be manageable. Aggregating or consolidating variables makes the model manageable. Later the aggregated variables may be separated after further understanding the system and the operating structure. With this approach, input variables that are explicitly modeled include:

Student Pilots per Class

Upgrading Instructor Pilots per Class

Instructors per Class

Flying Sorties Required for Transition Course

Flying Sorties Required for Upgrading Instructor Pilots

Academic Training Hours for Transition Course

Academic Training Hours for Upgrading Instructor Pilots

Number and Type of Aircraft Reserved for Training

Airwork Areas Allocated to Training

Starting Month for Training

Other variables are also involved in the training structure. The scheduling process is dependent upon the weather cancellation rate, daylight hours, aircraft failure rate, repair time, mission effectiveness rate, and flying time. These are modeled as random variables.

A random variable has a probability distribution associated with it. A probability distribution is a rule which assigns a probability to each possible value of a random variable. (10: 19) Assigning probabilities requires identifying the underlying probability distribution of a random variable and defining the parameters of that distribution. This process is discussed later in more detail. The following were treated as random variables in the model:

Weather Cancellation Rate

Daylight Hours

Aircraft Failure Rate for Preflight Check

Aircraft Failure Rate for Postflight Check

Ground Abort Rate

Aircraft Repair Time

Mission Effectiveness Rate

Flying Time

Model Development

Data Collection. The major sources of data are ROKAF/HQ, USAF/ASD, USAF/ILC, and USAF/TAC. As previously mentioned, the ROKAF has no experience operating F-16 aircraft and no historical data. Most of the available data are based upon USAF experience.

The weather cancellation rate, daylight hours, and airwork areas allocated for training are the data gathered from the ROKAF/HQ. The interviews with USAF/ASD/YPXI and USAF/ILC personnel provided insight into the operation of the training system. Information on the number of student pilots, the number of instructor pilots assigned, the number of aircraft allocated for training, and the general structure of the F-16 pilot training were obtained from these interviews. The training syllabi of the transition training course and upgrading instructor pilot course and maintenance support data came from the USAF/Tactical Air Command. After gathering the data, probability distributions must be developed.

The general approach to formulating a theoretical distribution is stated before discussing any specific data collected on the random variables. Usually four steps are used in the analysis of input data. These are collection of raw data, identification of the underlying statistcal distribution, the estimation of parameters, and the goodness of fit test. (1:332) After the data are collected, they are tabulated for plotting histograms or frequency distributions. Next, a determination is made as to what distributions are most likely to fit a given set of data. Visually comparing the histogram to a possible probability distribution gives an idea about likely probability distributions the data may fit. Afterwards, the distributional assumption is reduced to a specific distribution by applying a theoretical distribution over the histogram and estimating its parameters. The estimators often used are maximum likelihood estimators (MLE) based on the raw data. (1:345) Maximum likelihood estimators are used in this study to estimate the parameters of distribution. Once a distribution and its parameters are found, they are tested to determine whether the hypothesized distribution fits the data. Plotting and a goodness of fit test is used to determine if the theoretical distribution fits the data. Two statistical tests, the Kolmogorov-Smirnov (K-S) test and Chi-Square test, are applied to testing the hypothses about the distributional form of input

data. The K-S test is used for small sample testing, while the Chi-Square test is valid for large sample sizes. The K-S test is adopted to test the goodness of fit because sample sizes are relatively small. If the hypothesis that the hypothesized distribution fits the data is not rejected, the distribution and parameters are used in the model. If not, another distribution is tested for a better fit. Application of the methods above and the results are discussed next.

Flight training is very sensitive to weather conditions. Weather may not permit flying. The weather cancellation rates in Korea are available by month for the last five years. There are a variety of ways of using these data-- finding one distribution for a year with all the data points or making twelve distributions, one for every month. Because the weather differs considerably from season to season, using a single distribution is unrealistic. The number of data points is too few for the twelve month basis. Thus, data are grouped by the four seasons.

A normal distribution is hypothesized for each season, because it appears to adequately fit the empirical data. Histograms and theoretical distributions illustrating this fit are presented in Figure 1 through Figure 4. The distribution parameters, the mean and variance, are based upon the assumption of normality. With a 90 percent critical value of 0.304, the K-S test was applied to test

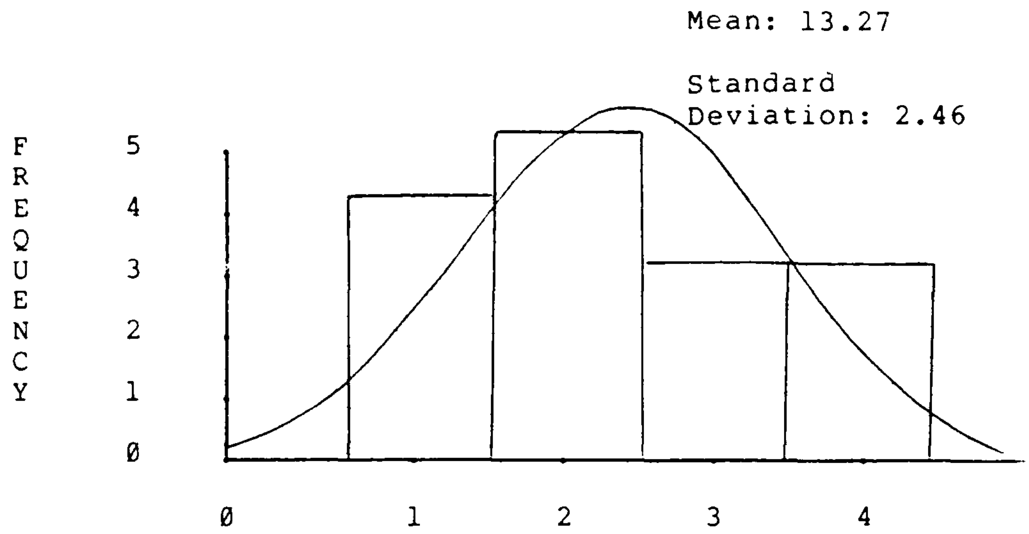


Figure 1. Spring Weather Cnacellation Rate

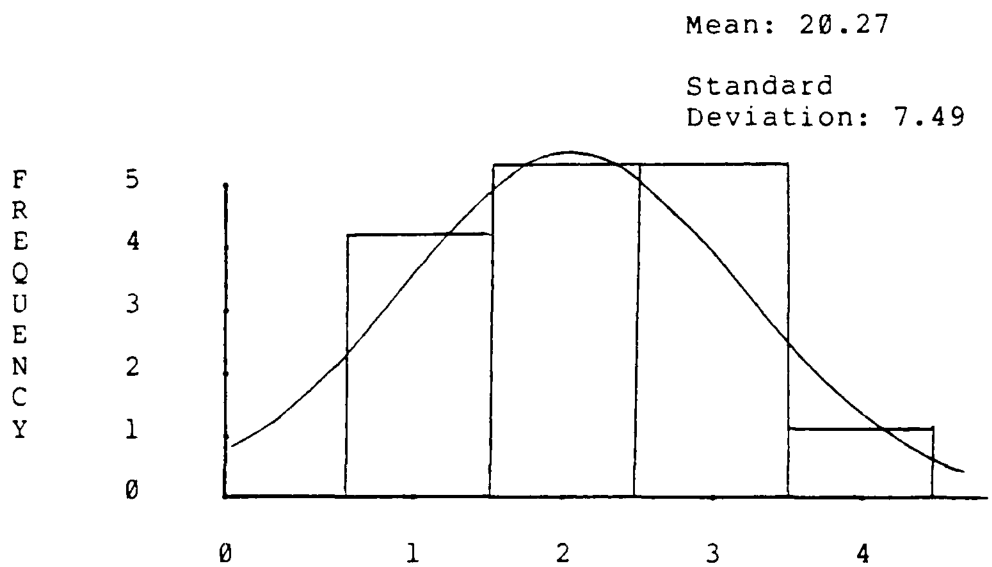


Figure 2. Summer Weather Cancellation Rate

Mean: 15.67

Standard
Deviation: 6.39

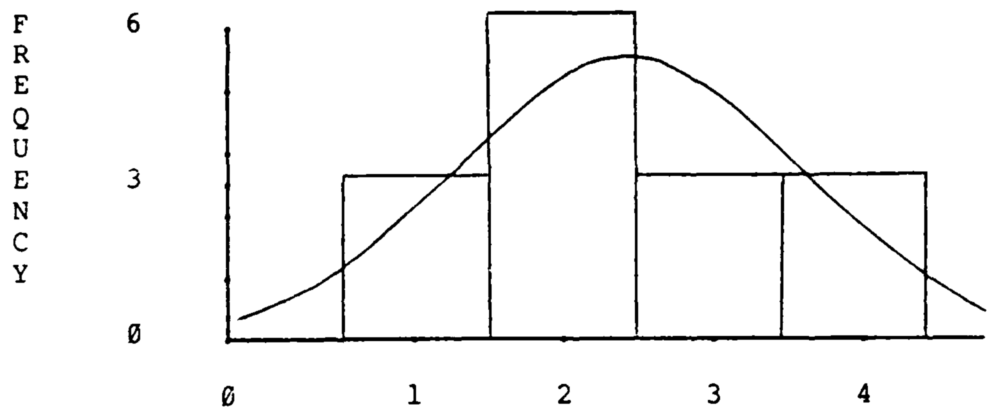


Figure 3. Autumn Weather Cancellation rate

Mean: 15.13

Standard
Deviation: 7.11

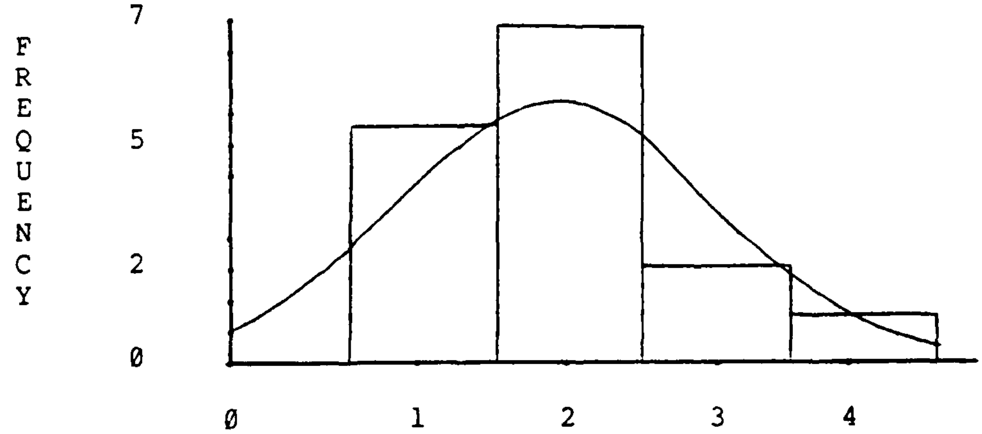


Figure 4. Winter Weather Cancellation Rate

the hypotheses. The K-S test statistics are shown as follows:

Seasons	K-S Test Statistics
Autumn	0.1577
Winter	0.1633
Spring	0.1431
Summer	0.1142

Each statistic is less than the 90 percent critical value, so the K-S test does not reject the hypothesis that each weather cancellation rate is distributed normally.

The transition training and the UIP training do not require night training. Thus, the sortie generation per day is limited to daylight hours. The data on daylight hours in Korea were gathered semi-monthly for one year. Again a single distribution for the whole year does not cover the deviations of each season. For this reason, a four seasons approach is adopted like the weather cancellation rate for each season. But, the daylight hours of Summer and Winter have relatively very small variances with means of 13.7 and 10.4, respectively. So these variables are treated as constants, and only the daylight hours of Autumn and Spring are treated further. It is hypothesized that daylight hours of each season have a underlying uniform probability distribution. Each K-S test statistic is less than the 90% critical value (0.468), so the null hypotheses can not be rejected. The K-S test statistics and estimated parameters are:

Season	K-S Statistics	Mean	Standard Variance
Spring	0.333	12.0	0.5774
Autumn	0.1667	11.5	0.1667

Unfortunately, not many data points were gathered for the maintenance support complex. Intuitively, the aircraft sortie generation process has various underlying probability distributions. The aircraft failures during preflight check and post flight check, ground abort, and repair time are random variables. Only average values for these random variables were available. (13) The probabilities of aircraft failure need to be considered carefully because the aircraft resources are limited, and the number and type of aircraft may affect the scheduling process. A student pilot can not fly his mission successfully when one of the flight, either instructor pilot or another student pilot and an instructor pilot, is aborted. Only a dual seat F-16D with an instructor can continue to fly, but the student still can not meet the mission standards, and the mission is treated as an additional one. If no spare aircraft are available when the aircraft is broken, the flight aborts its mission. The aircraft failure rates in a flight are binomially distributed. Assuming the probability of failure for a single F-16C or F-16D aircraft is p, the probabilities of aircraft failure for various aircraft mission combinations are as follows:

P (1 F-16D failure/ 2 F-16Ds flight)= $2*p*q$

P (2 F-16Ds failure/ 2 F-16Ds flight) = p^2

P (1 F-16C failure/ 1 F-16C, 1 F-16D flight) = $p*q$

P (1 F-16D failure/ 1 F-16C, 1 F-16D flight) = $p*q$

P (both failure/ 1 F-16C, 1 F-16D flight) = p^2

The mission effectiveness rate and flying time were initially assumed as random vaiables. The flying time may be different between air-to-air and air-to-ground missions. However, no empirical data were available. Therefore, the average assigned mission flight time is used in the model instead of the actual one. In addition, all the sorties flown may not be completed successfully. In other words, if the required proficiencies or standards are not achieved, additional instructional sorties are needed. Alternative approaches taken for these discrepancies are to use the numbers in the training syllabi. The additional instructional sorties are limited to four sorties for the course. (11:10) This maximum allowance is used as a worse case for mission effectiveness.

Flight Training Mission Types. The twenty-two missions for the transition training are grouped into six mission types according to the number of student pilots (SPs), the number of instructor pilots (IPs), and the number and type of aircraft (Table I). The sixteen missions for the upgrading instructor pilot (UIP) training are grouped

into three mission types (Table II). In addition, alternative mission types are required in case resources are not available for the existing mission types.

Table I

Transition Training Mission Type

Mission Type	Student Pilot	Instructor Pilot	Aircraft Number & Type	Syllabus Mission Number
1	1	1	1 F-16D	1,2
2	1	1	2 F-16C	5,9,10,11, 12,13,17, 19,20,22
3	2	2	2 F-16D	3,4,16,18
4	1	2	1 F-16C 1 F-16D	6,7
5	1	2	3 F-16C	14,15
6	2	2	2 F-16C 1 F-16D	8
7*	2	3	3 F-16D	8,14,15
8*	1	2	2 F-16D	3,4,5,6,7, 8,9,10,11, 12,13,16, 17,18,19, 20,21,22
9*	1	3	3 F-16D	8,14,15

* Mission types 7,8,9 are alternatives.

There are many possible combinations of aircraft, IPs, and SPs. As an example, the fifth mission requires two F-16Cs and one IP as shown in the Mission Type 2 (Table I).

Table II

UIP Training Mission Type

Mission Type	Student Pilot	Instructor Pilot	Aircraft Number & Type	Syllabus Mission Number
1	2	1	1 F-16C 1 F-16D	3,4,5,6, 10,11,14
2	2	2	2 F-16D	1,2,3,4,5, 6,10,11,12, 13,15,16*
3	2	2	2 F-16C 1 F-16D	7,8,9
4*	1	2	1 F-16C 1 F-16D	3,4,5,6,10, 11,14
5*	1	2	2 F-16D	1,2,3,4,5, 8,9,10,11, 13,14,15,16

* Mission Types 4 and 5 and Mission Numbers 3, 4, 5, 6, 10, and 11 in Mission Type 2 are alternatives.

The students follow the syllabus as strictly as possible, but if no F-16Cs are available or only one F-16C is available, then what should be done? This mission may be replaced with one F-16C and one F-16D, or two F-16Ds. Before the solo flight (fifth mission), the dual-seat F-16D can not be replaced with the single-seat F-16C. For flying safety reasons, only the single seat F-16C may be replaced with the dual seat F-16D if necessary. As another example, the third mission consists of two SPs, two IPs, and two F-16Ds as shown in Mission Type 3 (Table I). If all SPs have completed the third mission except one, then the last SP has

no partner to fly the third mission. The third mission of the last SP can be changed to another one which consists of only one SP with the same mission tasks. In this case the alternative is Mission Type 8 which consists of one SP, two IPs, and two F-16Ds. For this study, the alternatives are consolidated as discussed above. The Mission Types 7, 8, and 9 in Table I are provided as alternatives for transition training and the Mission Types 4 and 5 in Table II are alternatives for UIP training. The primary mission types and alternatives for transition and UIP training are shown in the Table I and II.

Model Assumptions. The following assumptions are used in the model:

1. The proposed F-16 squadron structure represents the one which will be created.

2. No simulator is used for training. The ROKAF is considering a plan of sharing the USAF simulator at Kunsan Air Base, Korea. But, even if it is possible, the simulator training will not be given during the flying training.

3. There may be differences between the USAF maintenance support ability and the ROKAF ability. The aircraft failure rate of F-16C/D is worse than the rate of F-16A/B. But only F-16A/B data obtained from the USAF are used in the model.

5. Support personnel, materials, and facilities are assumed to be sufficient to support the flying and academic training.

6. The student attrition rates are not considered. Because the entry prerequisites are very tight and the ROKAF selects highly experienced pilots as students, the student attrition rates are expected to be negligible.

7. The weather conditions may vary considerably from minute to minute. Because the flying training requires good weather condition from one hour before takeoff to one hour after landing, it is assumed that the weather conditions are checked every four hours.

8. The possible alternative mission types are limited to the substitution of F-16Cs for F-16Ds and the replacement of the mission types requiring two SPs with the mission types requiring one SP.

9. The UIP academic training during the flying training period requires sixteen hours. Thus, two more preflight academic training days are added.

Model Building. The model can be divided into three sections, i.e. transition training, UIP training, and subroutines common to transition and UIP training such as academic training, weather cancellation, daylight hours, postflight check, weather abort, aircraft failure, and aircraft repair subroutines. The mathematical model (Figure 5 and 6) and the computer source code listing (Appendix F)

are referred to in the following discussions of the program's operation. The SLAM network model starts processing with the creation of students. Two separate creations produce transition training student pilots and UIPs. A dummy entity created at the same time is used for changing the instructor pilots during the ground training days, changing the allocated aircraft resources, and assigning class numbers. The transition training module, the UIP training module, and other modules are discussed in detail along with the general flow of the model.

Transition Training Module.

General. Once the student pilots are created, they take preflight academic training and are each assigned the following attributes: sorties flown, academic hours trained, and starting day of flight training. The ground training for the transition course takes nineteen days and involves ninety academic hours. The preflight academics do not cover all academics required. The remaining hours are spread evenly over the flying training period.

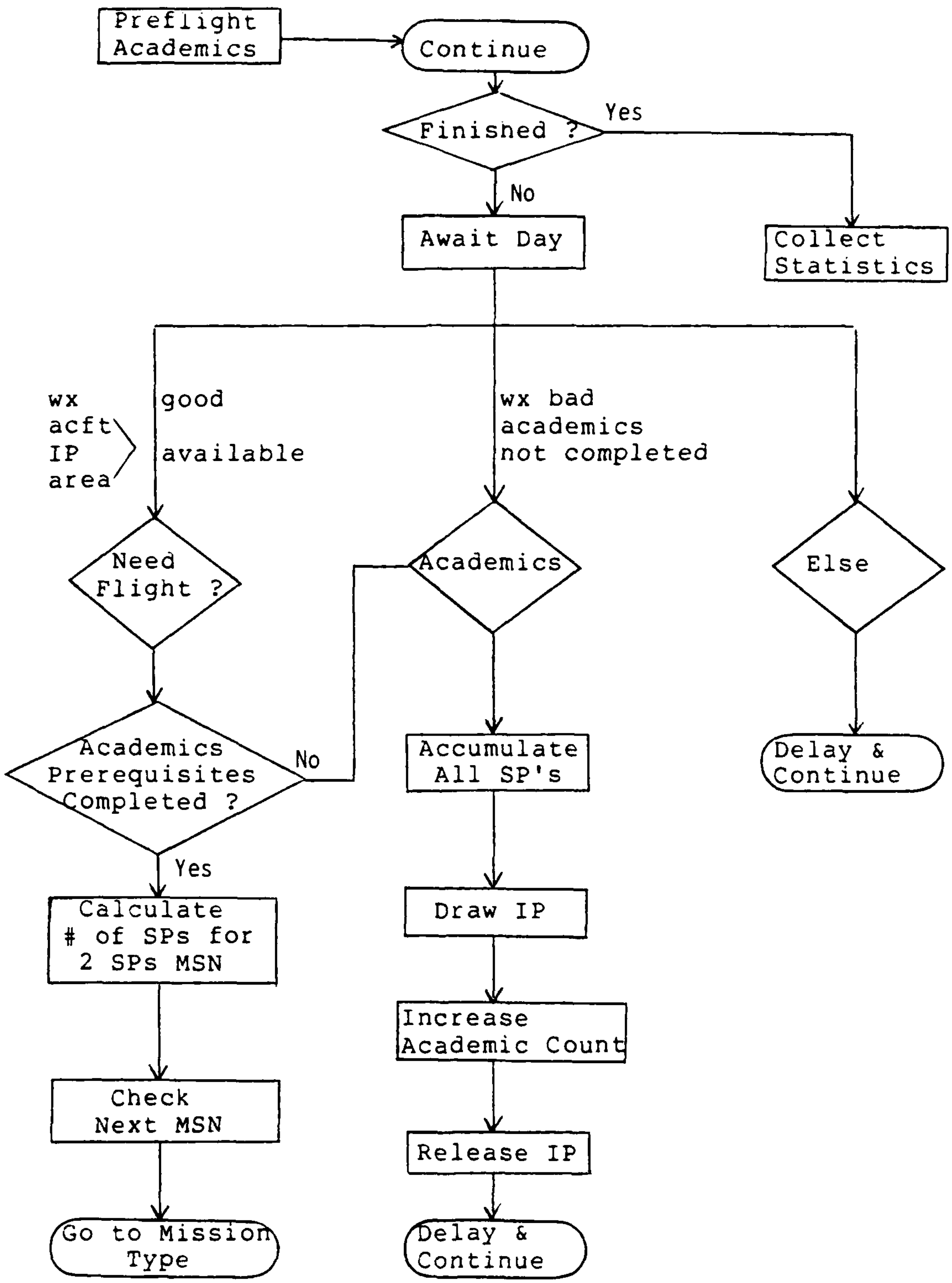


Figure 5. Phase Logic Flowchart

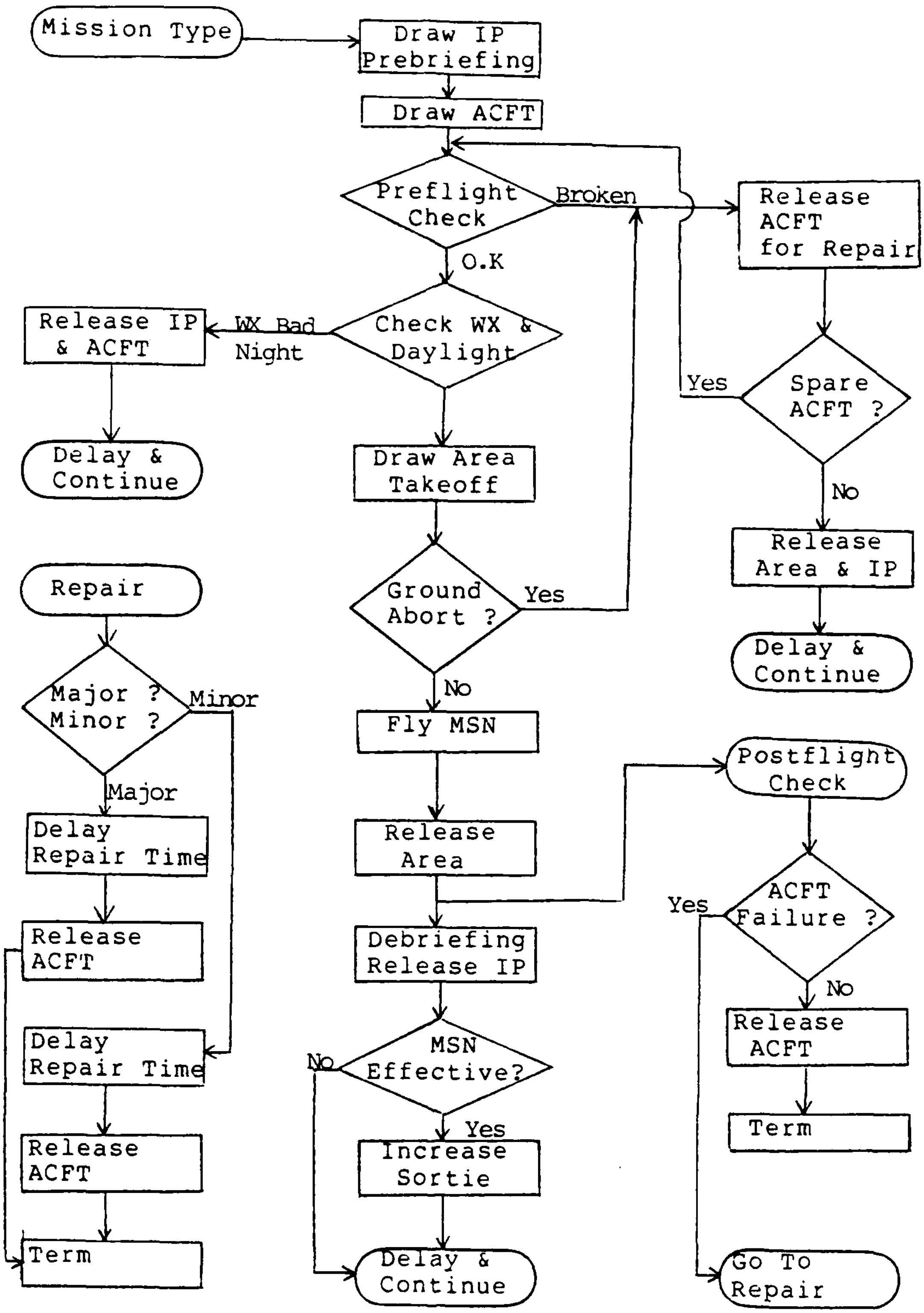


Figure 6. Typical Mission Type Flowchart

After the completion of preflight academics, the students start transition flying training. If the syllabus requirements are not complete, the students proceed to the next activity. A student usually flies a mission a day. (11:26)

The student are scheduled academics, flying, or delayed depending upon weather conditions and availability of instructor pilots, aircraft, and areas. The students scheduled for flying are checked to determine whether the academic prerequisites are completed.

Checking Academic Prerequisites. At this point, some necessary modifications need to be discussed. The academic training during each flying period is grouped into flying training modules. As mentioned earlier, a new module has specific academic prerequisites. In no case does flight training precede the related ground training. The academics of the same module are grouped together and completed before the new module starts so that the program does not violate SLAM language's upper bound limitation on statistical arrays.

Selecting Mission Type. If all academic prerequisites are complete, then the students check how many students pilots have completed for the missions requiring two students pilots. As previously explained, if no partner is left to fly with him, the student selects an alternative

mission type which consists of one SP with the same tasks. The students are scheduled according to the sorties flown, the remaining aircraft resources, and other prescribed conditions.

Typical Mission Type. Once the mission type is chosen, the students are scheduled for the appropriate mission type. Every mission type has similar structure with the execption of resource requirements such as IPs, and number and type of aircraft. After assigning the mission type, if two student pilots are needed, the first student waits until a second student pilot requiring the same mission comes along.

The typical mission training process, as previously discussed, starts with a preflight briefing with the instructor. After the aircraft are assigned, the 30-minute preflight check is conducted. If the aircraft pass the preflight check, the students check the weather and daylight again and taxi out for take off. If the aircraft are not ground aborted, the missions are flown. The aircraft are branched to postflight check after the mission and the students conduct the one-hour debriefing. Next a check for completion of syllabus requirements is performed.

Academic Training. The students are scheduled for academic training in order to satisfy prerequisites for the next mission, in case of bad weather, to prepare for missions beyond the next one, or for review if all academic

training has been acomplished. If the students have taken eight hours of academics they are branched back to a continuing node. If not, the students await the academic training gate which will be open when all SPs are gathered or the night comes. When the night comes after all SPs are gathered, they return to a continuing node. The last SP closes the academic training gate after all SPs pass the gate. The students draw one IP, take one hour of academic training, and increase the academic training counter. Then they return to a continuing node.

UIP Training Module.

General. The UIPs are created from the second transition training class on. A dummy entity is used for altering an IP resource during preflight academic training and assigning the class number. The ground training for the UIP course takes five days and requires twenty-two academic hours. The additional sixteen hours of required academics are included by adding two more ground training days because of the SLAM statistical array limitation. The UIPs are assinged the values of sorties flown, academic hours taken, class number.

Next, the program checks if UIPs have completed their flying training and academic training. When day comes, the UIPs are branched to flying training depending on the weather conditions and availability of IPs and aircraft. Otherwise, the UIPs are delayed and continued.

Selecting Mission Type. The UIPs check the weather conditions and available resources for flying. If these conditions permit flying, then the UIPs check how many UIPs have completed the missions requiring two UIPs in order to decide whether to select an alternative mission type or not. Then the UIPs select a mission type according to sorties flown, resources available, and prescribed conditions.

The UIP mission types, except the first one, are the same as the ones in transition training. After assigning the mission type, the UIPs are branched to the same mission type module for transition training. After the flights, the program returns to UIP mission type, checks if the mission is effective, and adjusts their sortie counters for the UIP as appropriates.

Other Modules.

Weather Cancellation Subroutine. A weather cancellation rate is drawn from a probability distribution in a FORTRAN program. If the weather is bad, the weather gate is closed for four hours. The FORTRAN event subroutine releases the students waiting IPs, or another SPs in a file. Then the weather cancellation rate is drawn again.

Daylight Subroutine. First the day gate is open. At the same time the academic training gate is closed for

gathering all SPs, if necessary. Then the daylight hour is drawn using a FORTRAN subroutine. After the daytime, the daylight gate is closed, and the daily counters are reset to zero. Again the FORTRAN event subroutines remove the SPs awaiting IPs or other SPs from a queue and file them in the await day queue. The academic training gate is opened in order to return the SPs at the awaiting academic training gate.

Weather Abort Subroutines. If the weather is bad or night comes before takeoff, the students release all the resources grasped, return to the starting point, and wait for daylight hours or are branched to academic training.

Aircraft Failure Subroutines. These subroutines are used for releasing failed aircraft for repair and drawing spare aircraft if available. When aircraft failures occur during preflight check or aircraft are ground aborted, the failed aircraft are released for repair. The students then check whether spare aircraft are available. If available, the students draw the spare aircraft, perform the preflight check, and continue the mission. If not, the students release all the assigned IP's, aircraft, and areas. They are delayed for three hours and then continue.

Postflight Check Subroutines. The 30-minute aircraft post flight check is performed by the maintenance crew. Failed aircraft are sent to the repair subroutine. If the aircraft is not broken, it is released to aircraft resources.

Aircraft Repair Subroutines. All failed aircraft sent from preflight check, ground abort, and postflight check are repaired in two subroutines for major repair and minor repair. After an aircraft is repaired, it is returned as a resource available for flying.

All these relationships described above are translated into a SLAM network simulation model. Appendix F lists the complete SLAM source code, and Appendix G contains FORTRAN subroutines which compute the weather cancellation rate and daylight hours. A FORTRAN subroutine also insures that the student pilots waiting either for IPs or other SPs go back to the awaiting day node.

Verification

Verification is the process of assuring that the simulation program actually behaves as the programmer intended. Verification is the comparison of the conceptual model to the computer code to see if the code accurately reflects the flow and logic of the conceptual model. (1:375) The more complex a model is, the more time consuming the verification process is. There are many ways to attempt to reduce the potential frustration of verification. Some of these techniques are (1:375-379):

1. Program the system module by module. Before adding a new module to the main program, check to see if a module behaves correctly.

2. A flow diagram of the conceptual model provides a good method for checking the logic flow.

3. Have other programmers check the code.

4. Careful examinations of output checks the reasonableness of the modules.

5. Adequate documentation of the code makes tracking-down errors easier.

Flowcharts of the logic flow were prepared for major program modules. An example of the flowcharts is given in Figure 5. The purpose of this is to prevent logic errors in the program. Logic errors are the most difficult to find. The flowcharts were most helpful in checking all possible logic paths.

Whenever a new module is added to the main program, the output result was investigated. The reasonableness of the printouts was verified by checking the SLAM trace outputs. The full documentation was a great aid in detecting errors. All techniques discussed above were used for model verification.

Validation

Validation is the overall process of comparing the model and its behavior to the real system. Because far reaching decisions may be made on the basis of simulation results, validation of simulation models is of great importance. The subtle difference between verification and

validation is that the former is the comparison of a model to the designer's intentions while the latter is the overall comparison of a model to the real system. The model calibration process takes a major part of validation. The model results are compared to expected results of the proposed system and adjustments are made if necessary. An iterative process of calibrating a model increases the model's accuracy. (1:383-387)

As an example, in early runs of the model the UIP classes were finishing their training too quickly. When the trace outputs were checked, it was found that they were flying twice a day. A modification was made to allow only one sortie per day. This calibration made the model output more closely match the recommended number of training days in the syllabus.

The validation process was very difficult in this study because the ROKAF has no experience with F-16 training. The lack of historical data does not allow full validation of the model. Thus, after running the simulation with estimated values, the output of the model was compared with the values the training syllabi recommend.

The following steps are recommended aids in the validation process: 1. Check the model for face validity. 2. Validate the data assumptions and structural assumptions. High face validity is obtained with the assistance of potential users and other knowledgeable

persons' inputs. All the data and operational structures were gathered from the planners; the output of the model was evaluated for reasonableness by the planners. These processes increased the face validity of the model. Reliable data and correct statistical analyses of the data validate the data assumptions. Structural assumptions are validated by actual observations. For full validation the model still requires better historical data.

Summary

The discussion of the F-16 training environment includes the proposed F-16 squadron structure and training process. The squadron structure explicitly represents the status of the training situation, the number of transition student pilots, UIP's, aircraft allocated, areas available, and the number of classes to be trained. The training process represents the academic and flying training requirements of both courses. Furthermore, the training flow, scheduling of flight operations, and the typical training mission are discussed in detail. The review of squadron structure and training process identifies various components and variables. From the components identified the input variables and other random variables are extracted.

After fully understanding the system operation, a SLAM model is constructed. The major sources of the data are

ROKAF/HQ, USAF/ASD, ILC, and TAC. Not enough data exist for full development of the random variables. The information from the syllabi and the average values for the maintenance system variables are used for the random variables on which data are not yet available.

A variety of model assumptions were used in the model construction. Certain simplifying assumptions were made to insure the whole program did not violate the upper bound of SLAM statistical arrays. The primary syllabi instructions and its alternatives increase the realism of the program.

Finally, verification and validation of the model are discussed. Programming module by module and checking the trace output are time-consuming processes, but all the efforts taken ensure the model behaves as intended. Validation was very difficult because the F-16 training system is a proposed one for the ROKAF. Close cooperation with the planners improved face validity, but the model still requires more data for full validation.

IV. Experimental Design

Introduction

This chapter discusses the experimental design of the model. The independent variables or factors are selected and investigated in the experimental design. The factor levels are chosen from expected levels by the planner. The responses to be measured are also chosen to provide information about the research questions. Then, the choice of experimental design is discussed, followed by the number of runs and sample sizes.

Selection of Factors

The model variables which could be used as factors in the experimental design are shown in Table III. The controllable variables can be divided into two major categories: the syllabus requirements and resource factors related to the implementation plan. The syllabus requirements for transition (TX) and UIP are number of flying sorties and academic training hours. Because these requirements were designed specifically to produce qualified pilots, it does not seem reasonable to vary these requirements. The other factors are number of SPs, number of IPs, number and type of aircraft (ACFT), and number of airwork areas. The ROKAF has tenatively assigned the number of SPs and the resources, IPs, F-16Cs, F-16Ds, and areas.

Table III

Model Variables

Controllable Variables	Random Variables
SPs per Class	Weather Cancellation Rate
UIPs per Class	Daylight Hours
SPs per Class	Preflight Check Failue Rate
Flying Sortie for TX	Postflight Check Failure Rate
Flying Sortie for UIP	Ground Abort Rate
Academic Hours for TX	ACFT Repair Time
Academic Hours for UIP	Mission Effectiveness Rate
Number and Type of ACFT	Flying Time
Number of Airwork Areas	

Since the ROKAF's primary concern during the F-16 implementation is producing F-16 pilots as soon as possible, uncertainties about these factor levels appear to be worth investigating. For example, various possible allocations of the limited number of dual seat aircraft among basic transition, UIP training, and the graduate training should be investigated.

The factors initially chosen for the experiment are the IPs, F-16Cs, F-16Ds, and areas. But, of these factors the number of IPs and areas appeared not to affect the overall training process in the first experiment. One more IP has a statistical significant effect on the system responses. The

average number of days to complete the entire training, transition and UIP training are reduced by one or two, which may not important in practical sense. Once the UIPs are trained, they are put into graduate pilot training, but can be converted to transition and UIP training anytime. Decreasing one airwork area does not affect the system responses. The test statistics (F-values) are ranging 0.0018 to 0.3537, which can not reject the hypothesis or the equality of cell means. The average utilization of each airwork area in the computer output was very low, the average of 0.12. For these reasons, a second selection was attempted. The number of transition student pilots and aircraft failure rates was considered instead of the IPs and areas.

Furthermore, of the random or uncontrollable variables the aircraft failure rates and ground abort rates have the potential to seriously affect the training environment and interact with other factors. The data used in the baseline model runs for ground aircraft failure rates and abort rates was for the F-16A/B. The F-16C/D has significantly worse failure and ground abort rates, which may have a serious effect on overall the system performance. But actual data were not available. Therefore, the aircraft failure rates and ground abort rates are grouped and selected as a factor in the experimental design.

Choice of Factor Levels

An overall investigation of selected factors identifies which factors have significant effect on the F-16 implementation and if any significant interactions exist among the factors. An interaction exists between factors when the difference in response between the levels of one factor is not the same at all levels of the other factors. If an interaction effect is large, the corresponding main effects have less practical meaning. Two levels of each factor spanning the range of likely values are enough to analyze all these interactions.

Two levels for each factor are defined as Level I and Level II. Level I is a baseline level for each factor-- the resource level initially allocated by the ROKAF or mean aircraft failure rate and ground abort rate. Level II is the resource factor level expected by the planner or the highest expected aircraft failure rate and ground abort rate which doubles the baseline failure and abort rate.

The possible changes of aircraft resources do not cover the whole training period. There is no choice in changing aircraft number and type until more aircraft are delivered. After the F-16Cs' arrival, one more F-16C can be allocated for the transition and UIP training and one F-16D can be transferred to graduate training. One more SP can be trained in each class, which will compress eight transition classes to seven classes. The aircraft failure rates and

ground abort rates are treated as a factor indicating normal failure rate or high failure rate which doubles the normal failure rate for the F-16A/B. Table IV displays the value of each factor level chosen for the initial experiment.

Table IV

Factor Levels

Factors	Levels	
	Level I	Level II
Number SPs	6	7
Number of F-16C	2	3
Number of F-16D	6	5
ACFT Failure Rate		
Preflight Check	0.025	0.05
Postflight Check	0.033	0.067
Ground Abort	0.067	0.133

Selection of Response Variables

The system's response is measured by the total number of days required for all classes to complete the full training program, including transition training and UIP training. The average days for each student pilot to complete the transition training and UIP training are another appropriate measure of the system response.

Choice of Designs

A factorial design investigates all possible combinations of the levels of these factors in each complete

trial or replication of the experiment. The change in the response variables due to a change in the levels of a factor and the interaction among factors are estimated at different levels of the factors.

As discussed above, the two levels allow 2^k factorials which provide the smallest number of treatment combinations with k factors for a complete factorial arrangement. (6:189-192; 261-262) A full factorial analysis of the four factors chosen, each at two levels, requires 2^4, or 16 runs. The full factorial design matrix is shown in Table V.

Run Length and Number of Replications

The technique used in the F-16 training model was to start the simulation with no classes in training. Classes begin its training every three months. After the desired number of pilots are produced, the program automatically stops. There is no inadvertent bias resulting from when the system starts, and the steady state characteristics are not of interest. Thus, determination of run length and starts of the steady state operation are not of major concern.

Table V Design Matrix

Run	Level I				Level II			
	a	b	c	d	A	B	C	D
1	*	*	*	*				
2	*	*	*					*
3	*	*		*			*	
4	*	*					*	*
5	*		*	*		*		
6	*		*			*		*
7	*			*		*	*	
8	*					*	*	*
9		*	*	*	*			
10		*	*		*			*
11		*		*	*		*	
12		*			*		*	*
13			*	*	*	*		
14			*		*	*		*
15				*	*	*	*	
16					*	*	*	*

where, a: 6 SPs
b: 2 F-16Cs
c: 6 F-16Ds
d: average aircraft failure rate
A: 7 SPs
B: 3 F-16Cs (from mid-second class)
C: 5 F-16Ds (from mid-second class)
D: high aircraft failure rate

But, the number of replications is very important to the accuracy of the results. A replication is a repetition of the basic experiment. With these replications, an estimate of the experimental error is obtained and becomes a basic unit of measurement for determining whether the observed data are really statistically significant. The more replications, the closer the estimates for the population.

Four factors were considered for the F-16 implementation process. Two factor levels for each factor and full factorial design requires 2^4, 16 runs for each replication. The complete factorial experiment includes all combinations of the levels of the factors taking one level of each factor.

After the number of runs is determined, the next step is to determine how many replications are needed for each run. This depends on the the desired sensitivity as long as the estimate is not seriously biased. To identify the full interaction between the factors, the multivariate analysis of variance techniques are used which require at least one more replication than the number of response variables. (4:213) Four replications for each run totals 64 replications.

The linear model for the full factorial design of the four factors is as follows:

Response = Mean + Main Effects + Interaction Effects + Error

The interaction effects consist of two-factor interactions, three-factor interactions, and the interaction of all four factors. The difference between the model response value and the mean is due to the effect of factors, the interaction effects and the experimental errors. The coefficients, or slopes, of the main effect terms and the interaction terms represent the average change in response, respectively. The statistical significance of the factors and the interactions is analyzed in Chapter V from the experimental results by using the analysis of variance technique.

Summary

Of the model variables, the number of student pilots, the type and number of aircraft, and the failure rate of aircraft were selected as factors for the experimental design. The aircraft failure rate, even though uncontrollable, was chosen as a factor because of tight aircraft resources. The factor levels were determined based on possible scenarios of interest to the planners.

A complete factorial design was adopted because the interactions between all factors are of interest and the 2^4

factorials require only 16 computer runs. The response variables are the number of days required for total completion of training and the number of days taken for transition and UIP training for each student pilot. The experimental design involves four replications for each factor combination, requiring 64 replications. Finally, the linear statistical model to be used to analyze the results was presented.

V. Analysis of Experimental Design

Introduction

This chapter discusses the results of the experimental design using the univariate and multivariate analysis of variance. The basic questions to be answered concern how each factor affects the days to complete the entire training program and the days required for transition training and upgrading instructor pilot training and if any, how the factors interact to influence the response variables. The one way analyses of variance reveal whether the difference between factor levels for each factor is statistically significant or not. The multivariate analyses of variance provide information about interactions among the factors. Finally, sensitivity analyses are conducted to determine how sensitive the system is to factors identified as being significant.

Analysis

Main Effects for Average Days to Complete Total Training. In the first experiment, the number of IPs has a weak significance (F-value: 4.9, tail probability: 0.03) on average days to complete the entire training. The number of areas are not significant with the tail probability of 0.97. The statistical results for the second experiment are found

in Table VI and Appendix C. The number of transition student pilots in each class has a statistically significant effect on the average number of days needed to complete the total training, while the number of F-16Cs, the number of F-16Ds, and the aircraft failure rate do not. The test statistics show no significant difference between the factor levels. Nevertheless, the mean delay for five F-16Ds, and high aircraft failure rates are six and ten days, respectively, which may be an important practical consideration. Table VI shows the values for the effect of each factor and two factor interactions for the response variable, the days to complete entire training. The descriptive analyses of these factors are represented in Figure 7a through 7d. The main effects for each factor are explained further in the following paragraphs.

Changing the number of transition student pilots in each class from six to seven has important significance. Increasing the number of student pilots by one in each class compresses the total training from eight classes to seven and reduces the total training days by 61.3. This result reveals that one more student can be trained with the resources allocated.

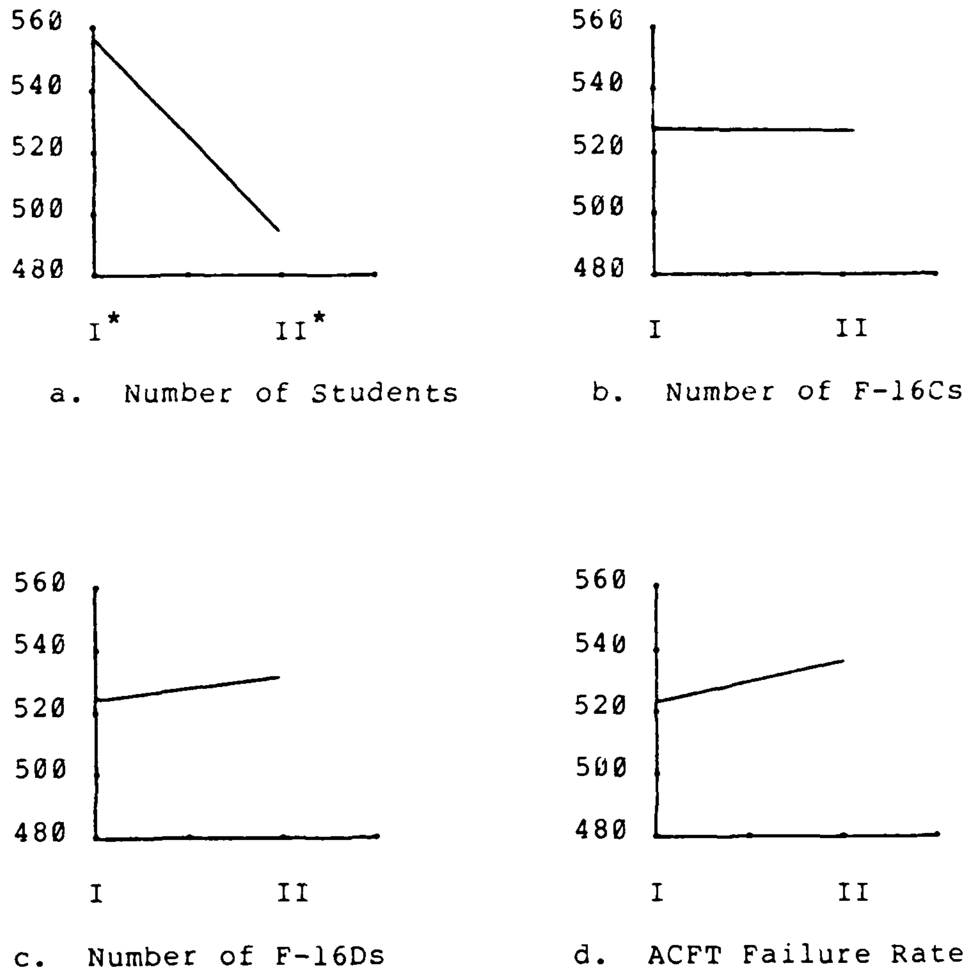
Table VI

Effect on Average Days to Complete Total Training

Factors/Interactions / among Factors	Effects for Each Level Combination			
	I,I*	I,II	II,I	II,II*
Number of Transition Student pilots (a)	558.0			496.7
Number of F-16Cs (b)	527.7			527.0
Number of F-16Ds (c)	524.1			530.5
Aircraft Failure Rates (d)	522.2			532.5
aXb	558.5	557.1	496.65	496.75
aXc	554.85	561.13	493.43	499.98
aXd	555.95	560.03	488.43	504.98
bXc	524.85	530.60	523.43	530.50
bXd	522.23	533.23	522.15	531.78
cXd	519.85	528.43	524.53	536.58

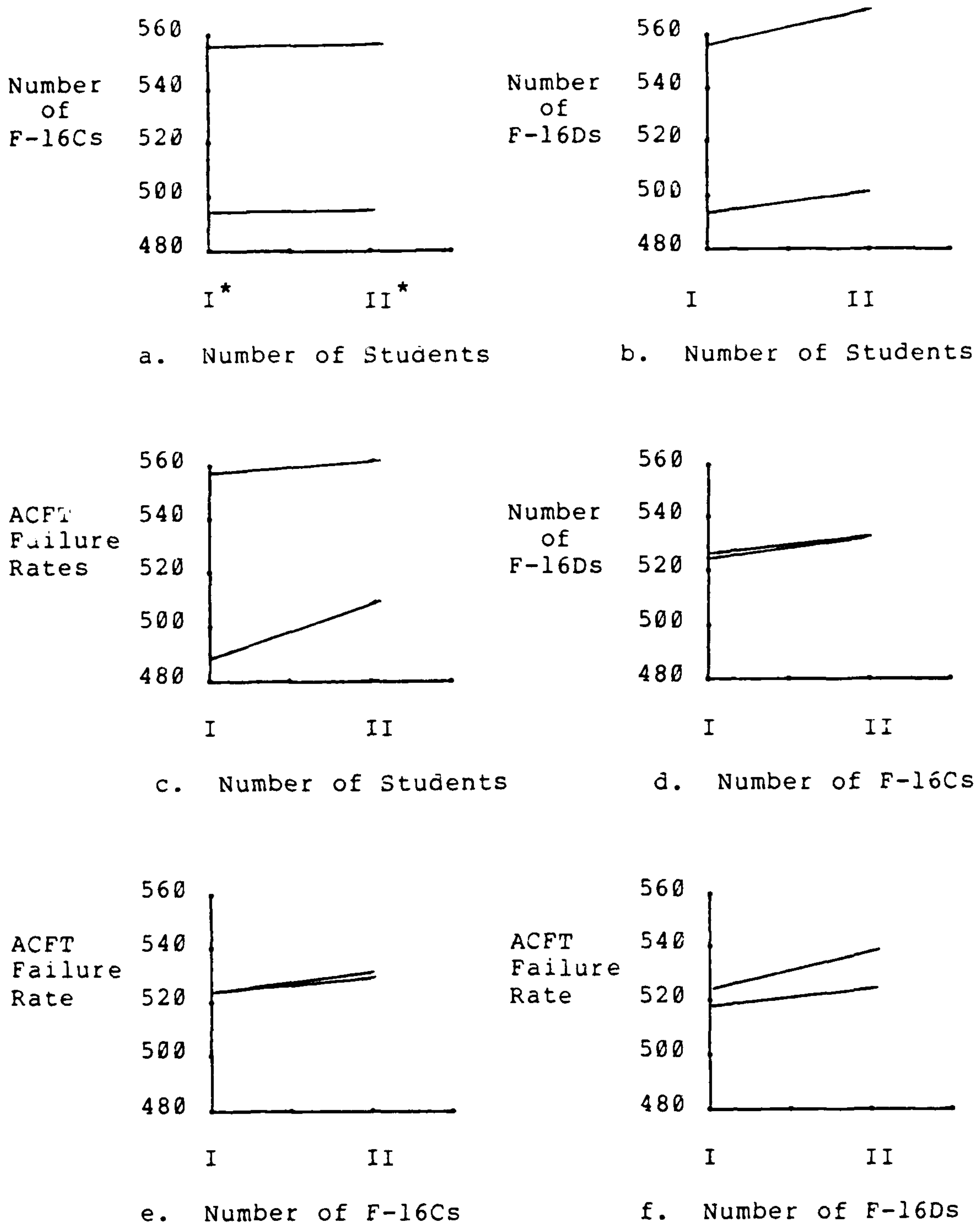
* I: Factor at baseline level
II: Factor at expected level

Increasing the number of F-16Cs from two to three has little significance. The first F-16Cs are delivered one month after the second class starts. Two of them are allocated for the transition and UIP training. Of the second delivery two months after the third class starts, two more F-16Cs are reserved for training. The first class does not use the F-16Cs at all. One additional F-16C from the



* I: Factor at baseline level
II: Factor at expected level

Figure 7. Main Effects on Average Days to Complete Total Training



*I: Factor at baseline level II: Factor at expected level

Figure 8. Interaction Effects on Average Day to Complete Total Training

first F-16Cs arrival on does not affect the total number of training days. This is to be expected because the alternative mission types are based on the substitution of the F-16Ds for the F-16Cs.

Decreasing the number of F-16Ds from six to five does not have a statistically significant impact on the response variables. It increases by six the number of days to complete training. Each new class enters transition and UIP training every three months. The transition class has nineteen days of preflight academics and the UIP class seven days. The former class can catch up its training and can even accomplish remaining syllabus requirements during the ground academic training period for the class following it in case of delays. For this reason, the delays for a class that push it a few days into the next class do not affect the overall results. This explains why the number of F-16Ds does not affect the response variable so long as there are no excessive delays.

The aircraft failure rate is not statistically significant with respect to the average days to complete the total training even when the rates are doubled. High aircraft failure rates increase the total training days by an average of ten days which is only about a two percentage increase. Here the same arguments apply as the effects of the number of F-16Ds. The ground training days probably cover the accumulated delays for the total completion.

Significant Interaction Effects on Average Days to Complete Total Training. The interactions among the factors are discussed using the descriptive figures and the test statistics. The F-values in Appendix D-6 show that only the interactions between the number of student pilots and the aircraft failure rates and between the number of F-16Ds and the aircraft failure rates are significant. Adding one more transition student pilot in each class, places a greater demand on the limited resources such as IPs, types and numbers of aircraft, and areas. This added demand delays the training and increases the number of days. Also, the high aircraft failure rate results in lower aircraft availability. As Figure 8a through 8f show, the seven transition students interaction with the high aircraft failure rates result in more increased total completion days from 488.4 to 505 rather than from 556 to 560 (Table VI).

Another significant interaction is the one between the F-16Ds and the aircraft failure rate. The main effects of these factors are not significant. However, changing these factor levels increases the total number of days for training by six and ten days, respectively. The decreased number of F-16Ds coupled with the high aircraft failure rates interacts with each other because the training is highly dependent on the dual seat F-16Ds. Yet, the increase

is only about ten days or about two percent. Practically speaking, this is probably not significant.

Main Effects for Average Days to Complete Transition Training. The transition training is a more important factor in determining the total days to complete the training than UIP training because the UIP training is shorter. In addition, because of short time, one UIP class may affect a transition training class but not another UIP class. Except for the F-16Cs, all other factors appear to be significant with respect to the average number of days to complete the transition training. Table VII, Figure 9a through 9d, and Appendix C are referred to in the following discussions.

Adding one transition student in each class delays the average transition training by 9.9 days. This means one more student pilot can be trained with the resources allocated, with a thirteen percent increase in average number of days over the time it takes to train six student pilots. But the total training days for all classes can be reduced by about three months because it eliminates the need for the last class. In other words, each student pilot takes ten more days to complete the transition training, but the days to produce the desired number of F-16 pilots are decreased considerably. Ten more days for each student pilot to complete transition training represent significant delay, but decreasing total training days by 61.3 which

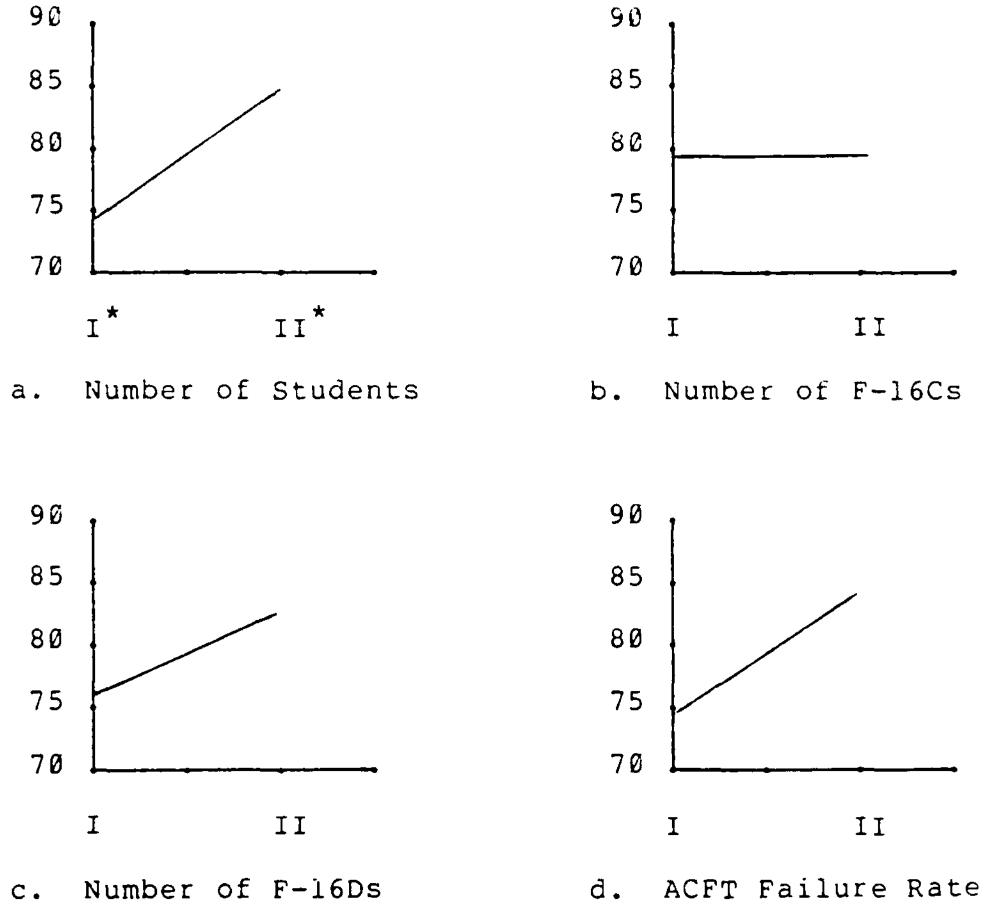
Table VII

Effect for Days to Complete Transition Training

Factors/Interactions / among Factors	Efects for Each Combination I,I	I,II	II,I	II,II
Number of Transition Student pilots (a)	74.41			84.27
Number of F-16Cs (b)	79.21			79.47
Number of F-16Ds (c)	75.76			82.91
Aircraft Failure Rates (d)	74.62			84.05
aXb	74.30	74.50	84.10	84.44
aXc	71.56	77.55	79.96	88.58
aXd	71.15	77.66	78.10	90.45
bXc	76.26	82.16	75.27	83.67
bXd	74.46	84.15	74.79	82.71
cXd	71.42	80.11	77.83	88.00

equates to three working month, seems to be more important to the planners.

Losing one F-16D after the first F-16Cs' delivery delays the transition training by an average of 7.1 days, which is statistically significant. The reduced number of F-16Ds degrade the sortie generation capabilities and increase the training days.



a. Number of Students

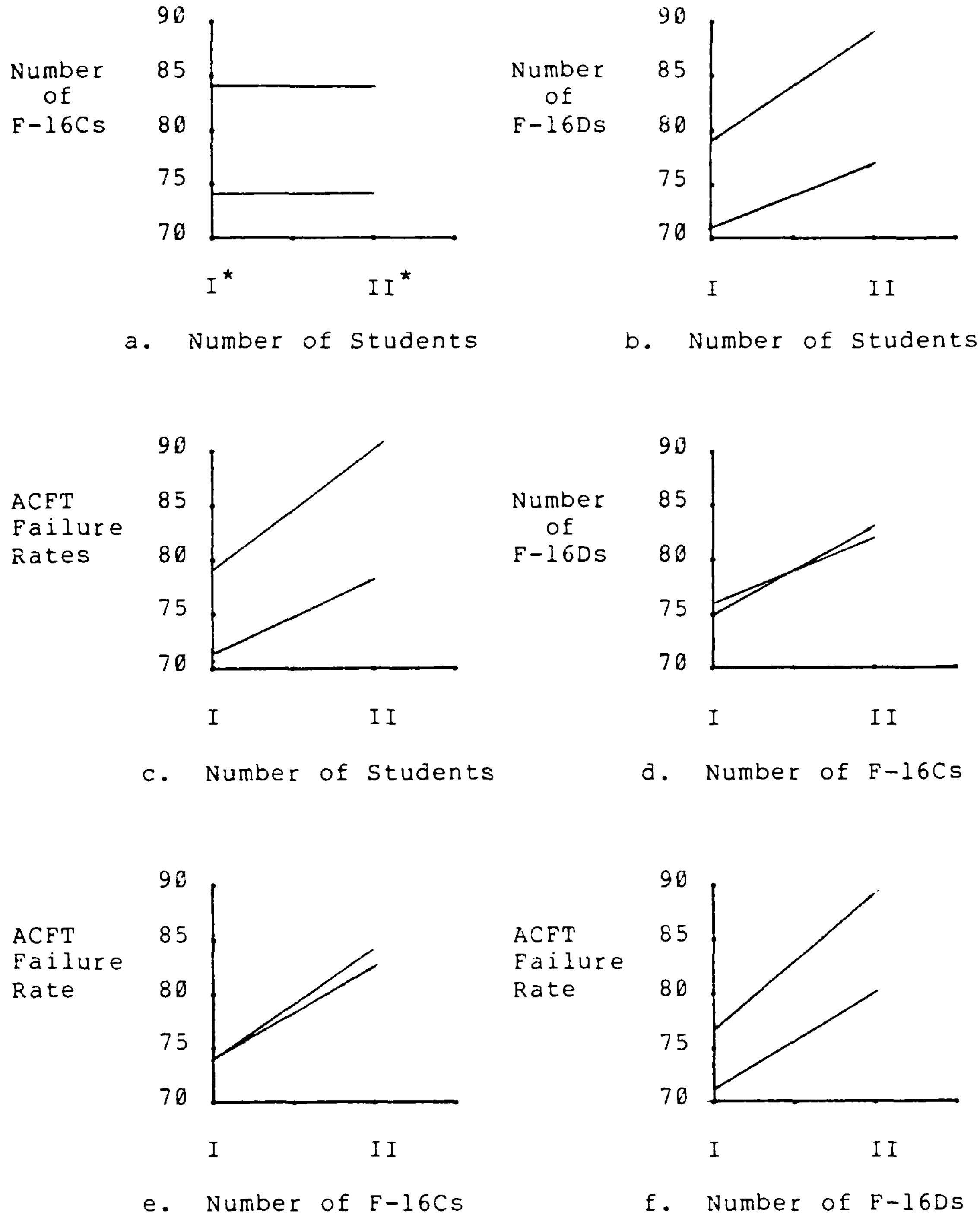
b. Number of F-16Cs

c. Number of F-16Ds

d. ACFT Failure Rate

* I: Factor at baseline level
II: Facotr at expected level

Figure 9. Main Effects on Average Days to Complete Transition Training



*I: Factor at baseline level II: Factor at expected level

Figure 10. Interaction Effects on Average Days to Complete Transition Training

Hign aircraft failure rates increase the transition training by 9.5 days, because the high aircraft failure rates reduce the number of sorties generated per day.

Interactions for Average Days to Complete Transition Training. Multivariate analysis of variance (Appendix D) provides an evaluation of the interactions between the transition student pilots and the F-16Ds, between the transition student pilots and the aircraft failure rates, between the F-16Cs and the F-16Ds, and between the F-16Ds and aircraft failure rates. The graphical results in Figure 10a through 10f depict these interactions.

Seven transition students are delayed significantly from 80 to 88.6 days when the five rather than six F-16Ds are allocated for training. The reduced number of F-16Ds constrain the number of sorties that can be generated in a day while the increased number of students require more sorties. Hence, significant interactions are present.

Explaining the significance of interactions of F-16Cs and F-16Ds is somewhat difficult because of the intersection of the effects which shows that any interaction is not important. An explanation is that F-16Ds are substituted for some of F-16Cs when Cs are not available.

The interactions between the transition students and aircraft failure rates and between the F-16Ds and the aircraft failure rates are explained in terms of sortie generation capabilities. Increasing each class by one

student requires more daily sorties, but high aircraft failure rates degrade the sortie generation capabilties. The combined effects interact significantly, and the days to complete transition training is extended considerably from 78.1 to 90.5. The effects of reduced F-16Ds are excerbated by the high aircraft failure rates.

Main Effects for Average Days to Complete UIP Training. The average days to complete UIP training may or may not be directly related to the total completion of the training, but it may affect the days to complete transition training and may delay the total completion. The test statistics and graphics are shown in Appendix C and Figure 11a through 11d. Table VIII summarizes the main effects and interaction effects on average days for each UIP to complete the UIP training.

The number of transition students has statistical significance with respect to the days required for UIP training completion. Because the UIP students share the avilable resources with transition students, this result is not unexpected. Increasing the number of transition students from six to seven requires on the average 5.3 more days for UIP training.

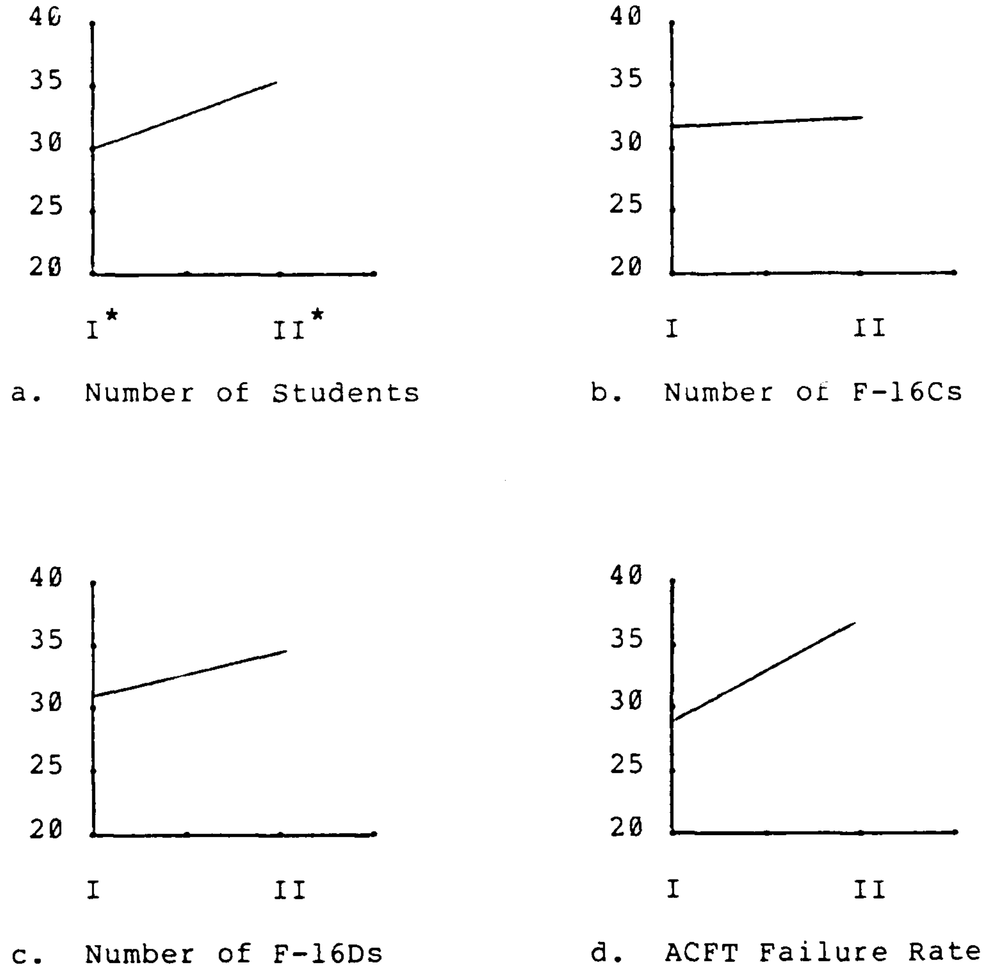
Table VIII

Effect for Day to Complete UIP Training

Factors/Interactions / among Factors	Effects for Each Level Combination I,I	I,II	II,I	II,II
Number of Transition Student pilots (a)	30.29			35.60
Number of F-16Cs (b)	32.26			33.63
Number of F-16Ds (c)	31.06			34.83
Aircraft Failure Rates (d)	29.85			36.04
aXb	29.76	30.83	34.76	36.43
aXc	28.95	31.64	33.18	38.02
aXd	28.21	32.38	31.50	39.69
bXc	30.48	34.05	31.65	35.61
bXd	29.66	34.86	30.04	37.21
cXd	28.21	33.92	31.50	38.16

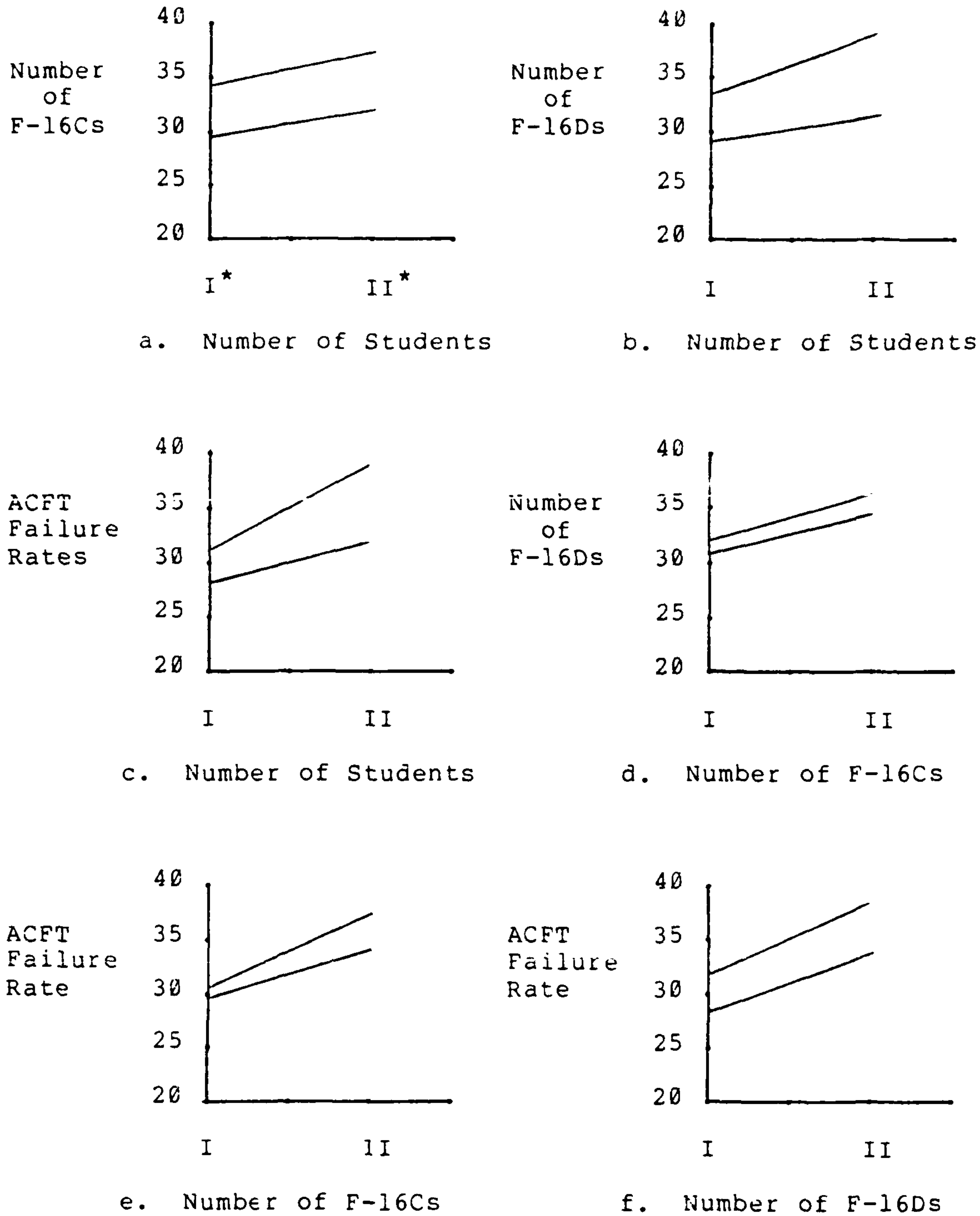
The F-16Ds and aircraft failure rates also have significant effects. Five instead of six F-16Ds delays the UIP training 3.8 days, and high aircraft failure rates increase the days by 6.2.

Interaction Effects for Average Days to Complete UIP Training. The significant interactions are the ones between the transition student pilots and the F-16Ds, between the transition students and aircraft failure rates, and between the F-16Cs and aircraft failure rates. These interactions



* I: Factor at baseline level
II: Facotr at expected level

Figure 11. Main Effects on Average Days to Complete UIP Training



*I: Factor at baseline level II: Facotr at expected level

Figure 12. Interaction Effects on Average Days to Complete UIP Training

are depicted in Figure 12a through 12f and Appendix D.

The first two interactions can be explained in the same way as for the transition training case. More student pilots require more sorties while the daily sortie generation is decreased by the reduced number of F-16Ds and high aircraft failure rates.

The interaction of F-16Cs and aircraft failure rates is more difficult to explain because the number of F-16Cs does not have a significant effect on all response variables.

Sensitivity Analysis

Next the sensitivity of the levels of these factors identified as important is examined. The purpose of this analysis is to identify at which level or levels of these factors the operation of the system is significantly affected. A sensitivity analysis was conducted on each of the factors selected. Each of the factors was tested in isolation by holding other factor levels constant at the baseline level defined in the experimental design. Four replications of each run were performed. Again the one-way analysis of variance (ANOVA) was used as the statistical tool.

Sensitivity to Transition Student Pilots. The number of transition student pilots was run for six and seven students in each class. The ANOVA for the number of

transition students appears in Appendix E-1. The tail probability value (p-value) equals zero for the total completion of the entire training, which means that the hypothesis or the equality of level means is rejected, and significant differences exist in the number of days for each student to complete the transition and the UIP training. The average number of days to complete the entire training decreases considerably by 68.9, while the mean number of days for the transition and UIP training increases.

Sensitivity to F-16Ds. The number of F-16Ds was run for six and five after the first F-16Cs are delivered. This means that after the second F-16Cs' arrival four or three F-16Ds are used for the transition and the UIP training. The results are statistical significance for all three response variables. But the actual changes in response variables do not appear very large in a practical sense. The statistical outputs are shown in Appendix E-2.

Sensitivity to Aircraft Failure Rates. The aircraft failure rate was run from low failure rates to nigh failure rates, which doubles the low ones. The low and the high values of aircraft failure rates and ground abort rates are the same as the ones previously used in the experiment (Table IV). The medium value is the average of these two values. The total number of days to complete training is not affected significantly, while the number of days to complete the transition and the UIP training is. The days

required for the transition and the UIP training increase more rapidly i.e. 3.4 and 2.6 days, respectively, as the failure rates are increased from the low rates to the medium ones than from the medium rates to the high ones. The ANOVA results are shown in Appendix E-3.

Sensitivity to Mission Effectiveness. The mission effectiveness rate is assumed equal to one minus the maximum allowable additional sorties of four divided by the total syllabus requirements times 100 ((1-4/22)x100). The additional sorties was run for 2, 4, and 6, which is equivalent to 0.92, 0.83, and 0.73 for the mission effectiveness rate, respectively. The ANOVA are represented in Appendix E-4. The mission effectiveness rate is significant for all response variables. The estimates of means show the responses of the system increase more steeply as the effectiveness rate varies from 0.92 to 0.83 than from 0.83 to 0.73.

Summary

The results of the experimental design were analyzed using the analysis of variance techniques. The results of the design of experiments were considered in order to find the statistical significance of the factor levels and the interactions among factors.

The days to complete entire training were not as significant as other responses because of the preflight

ground training. Except for the F-16Cs, all factors chosen for the experiment have significant effects on the number of days for each student to complete the transition training and the UIP training. The number of transition student pilots appeared to be the most meaningful factor. One more transition student pilot in each class delays the days required for the transition and the UIP training. However, with this additional student, the total number of student training classes can be compressed from eight to seven.

The interactions among the transition student pilots, the F-16Ds, and the aircraft failure rates are significant for the response variables.

Finally, a sensitivity analysis was conducted to find how sensitive the model is to those factor levels identified as significant.

VI. Conclusions and Recommendations

Conclusions

The F-16 implementation for the ROKAF is an extremely important issue. The Peace Bridge Program Management Plan, the Program Management Review, and the F-16 Implementation Plan are the major sources for this study. These plans address the procedures and factors planned for implementing the F-16 for the ROKAF. However, no systematic and formal detailed analysis of F-16 pilot training existed to identify the significant factors or to estimate the magnitude of the change in the system responses from a change in factor levels.

To provide the necessary analysis, a conceptualization of the F-16 flight training system was accomplished, and the key components and variables were identified. With this information, a SLAM simulation model of the F-16 training system, including the transition course and the upgrading instructor pilot course, was developed. Verification and validation were accomplished, and statistical results were obtained from the model.

Several variables, likely to affect the system were selected as factors for experimental design. The system reponse was estimated by measuring the number of days to complete the entire training, the number of days for each

transition student pilot to complete transition training, and the number of days for each upgrading instructor pilot to complete the upgrading instructor pilot training. A complete factorial design was used for the experiment in order to identify the main effects for each factor and the interactions among factors.

The results show that the number of the transition students in each class has the most significant effects on the days to complete the entire training. One more transition student in each class can compress the total transition training class from eight to seven. The total required days were not significantly affected by the factor levels of the number of F-16Cs, the number of F-16Ds, and aircraft failure rates because of the slack provided by preflight ground academic training days. In addition, statistically significant two-way interaction affecting the days to complete the training existed between the number of transition student pilots and the aircraft failure rates.

As an additional measure of system response, the days for each transition student to complete the transition were investigated because the days to complete the entire training is highly dependent on this measure. The number of transition students, the number of F-16Ds, and the aircraft failure rates have statistically significant effects on the days to complete the transition training. One more transition student in each class adds ten days for each

student's completion time. But as mentioned earlier, the entire training can be compressed by 61 days. The interaction among the factors, the transition students, the number of F-16Ds, and the aircraft failure rates have statistical significance.

Another additional measure of the system response is the number of the days for each upgrading instructor pilot to complete the training. The number of transition student pilots, the number of F-16Ds, and the aircraft failure rates appeared as statistically significant factors. These factors affect the number of the days required for upgrading instructor training, as well as the number of the days to complete the transition training and entire training. Also, interactions among the number of the transition student pilots, the number of F-16Ds, and aircraft failure rates exist.

The experiment shows that a number of factor interactions also affect the F-16 implementation for the ROKAF. Due to these interactions and general complexity of the system, the specific results of the experiment could not be accurately predicted. But the trends were shown. Therefore, the model provides a powerful tool for analyzing the effects of potential changes to the plan. The model also gave valuable insight into the behavior of the system during the initial transitioning phase. Finally the model can cover other scenarios by changing values of input variables.

Recommendations

Not all aspects of the system could be analyzed due to the scope of the study. Further study of other areas can provide additional insight and information to the ROKAF. Some of these areas are presented below.

This model incooperates several key assumptions. Some may need to be altered as the training proceeds.

1. The maintenance support ability of the ROKAF and the data for F-16C/D is assumed to be similar to that of the USAF and that for the F-16A/B.

2. The possible alternative mission types are limited to the substitution of F-16Cs for F-16Ds.

3. The flying time is assumed as the average assigned mission flight time.

4. A student pilot is assumed to fly a sortie a day.

5. It is assumed the simulator is not used for this training. The syllabus requirements of the flying sortie may be increased instead of the simulator training.

More sensitivity analysis can be performed on all these assumptions to determine the impact on the system responses. The simulation model can be used for showing the effects from a change of these assumptions.

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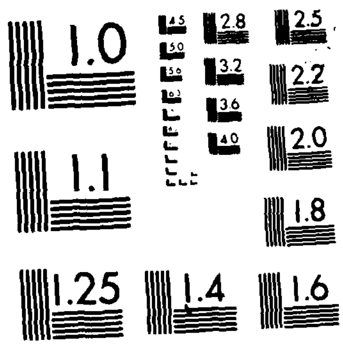

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Appendix A. Data for Design of Experiment

1	554.5	68.1	26.5	1	1	1	1
2	554.4	69.7	25.7	1	1	1	1
3	552.2	68.9	27.0	1	1	1	1
4	556.2	70.7	27.0	1	1	1	1
5	561.4	75.9	29.0	1	1	1	2
6	556.2	73.7	29.3	1	1	1	2
7	559.4	75.6	31.2	1	1	1	2
8	552.4	71.9	27.6	1	1	1	2
9	558.6	73.2	29.1	1	1	2	1
10	556.6	72.3	31.3	1	1	2	1
11	557.6	72.2	28.7	1	1	2	1
12	561.2	71.7	28.9	1	1	2	1
13	564.5	79.5	32.3	1	1	2	2
14	562.6	81.1	33.1	1	1	2	2
15	564.6	81.4	34.8	1	1	2	2
16	568.4	83.2	34.7	1	1	2	2
17	554.4	69.9	27.3	1	2	1	1
18	554.4	67.6	28.4	1	2	1	1
19	549.6	70.1	27.5	1	2	1	1
20	556.2	68.9	26.4	1	2	1	1
21	555.4	73.4	32.7	1	2	1	2
22	553.5	74.8	33.9	1	2	1	2
23	552.2	72.6	31.6	1	2	1	2
24	554.8	73.2	32.1	1	2	1	2
25	556.6	72.2	30.8	1	2	2	1
26	559.6	75.6	28.5	1	2	2	1
27	555.5	73.5	29.4	1	2	2	1
28	557.6	73.9	28.8	1	2	2	1
29	561.4	80.4	34.8	1	2	2	2
30	565.4	83.5	32.4	1	2	2	2
31	563.5	81.3	33.7	1	2	2	2
32	564.3	81.0	34.9	1	2	2	2
33	487.5	75.5	30.1	2	1	1	1
34	485.2	76.6	30.9	2	1	1	1
35	485.7	73.2	28.5	2	1	1	1
36	483.4	73.8	28.0	2	1	1	1
37	502.4	88.5	35.2	2	1	1	2
38	501.8	87.6	37.5	2	1	1	2
39	503.2	87.3	39.1	2	1	1	2
40	501.5	83.2	35.0	2	1	1	2
41	490.2	83.8	34.1	2	1	2	1
42	488.4	78.2	33.6	2	1	2	1
43	489.4	81.3	31.4	2	1	2	1
44	494.2	82.2	33.8	2	1	2	1
45	507.8	93.9	38.7	2	1	2	2
46	509.2	94.3	40.0	2	1	2	2
47	508.6	93.4	40.8	2	1	2	2
48	507.4	92.8	39.5	2	1	2	2
49	486.5	72.5	29.7	2	2	1	1
50	485.2	73.8	27.8	2	2	1	1
51	484.2	72.0	31.9	2	2	1	1
52	487.6	71.4	28.6	2	2	1	1
53	501.4	87.2	38.4	2	2	1	2
54	499.5	85.3	37.8	2	2	1	2
55	498.7	84.8	36.2	2	2	1	2
56	500.8	86.7	36.1	2	2	1	2
57	493.6	83.5	34.1	2	2	2	1
58	488.1	82.4	33.8	2	2	2	1
59	488.5	84.4	35.3	2	2	2	1
60	496.6	84.9	32.4	2	2	2	1
61	510.1	96.2	48.5	2	2	2	2
62	508.9	94.8	44.5	2	2	2	2
63	509.5	95.3	42.3	2	2	2	2
64	508.8	95.8	45.5	2	2	2	2

Coulumn 1: identification number
2: days to complete entire training
3: days for each student to complete transition
4: days for each student to complete UIP course
5: factor level for the number of transition SP
6: factor level for the number of F-16Ds
7: factor level for the number of F-16Cs
8: factor level for aircraft failure rates

Each row data represents one replication of the model.

Appendix B. Data for Sensitivity Analysis

Number of Transition Student

1	554.5	68.1	26.5	1*
2	554.5	69.7	25.7	1
3	552.2	68.9	27.0	1
4	556.2	70.7	27.0	1
5	487.5	75.5	30.1	2*
6	485.2	76.6	30.9	2
7	485.7	73.2	28.5	2
8	483.4	73.8	28.0	2

*1: 6 Students
2: 7 Students

Number fo F-16Ds

1	554.5	68.1	26.5	1*
2	554.5	69.7	25.7	1
3	552.2	68.9	27.0	1
4	556.2	70.7	27.0	1
5	558.6	73.2	29.1	2*
6	556.6	72.3	31.3	2
7	557.6	72.2	28.7	2
8	561.2	71.7	28.9	2

*1: 6 F-16Ds
2: 5 F-16Ds

Aircraft Failure Rate

1	554.5	68.1	26.5	1*
2	554.4	69.7	25.7	1
3	552.2	68.9	27.0	1
4	556.2	70.7	27.0	1
5	557.4	74.6	28.4	2*
6	556.5	73.1	29.0	2
7	551.6	71.6	30.2	2
8	558.6	71.6	28.9	2
9	561.4	75.9	29.0	3*
10	556.2	73.7	29.3	3
11	559.4	75.6	31.2	3
12	552.4	71.9	27.6	3

*	1	2	3
Preflight	0.025	0.038	0.5
Ground Abort	0.06	0.1	0.13
Postflight	0.033	0.05	0.067

Mission Effectiveness Rate

1	553.2	67.6	27.6	1*
2	552.2	67.1	27.3	1
3	551.2	66.3	26.9	1
4	549.5	66.2	25.9	1
5	554.5	68.1	26.5	2*
6	554.4	69.7	25.7	2
7	552.2	68.9	27.0	2
8	556.2	70.7	27.0	2
9	557.6	77.0	34.3	3*
10	555.2	76.0	32.3	3
11	561.6	77.0	33.8	3
12	559.8	78.1	33.5	3

*1: High (0.92)
2: Medium (0.83)
3: Low (0.73)

Appendix C. Statistical Results for ANOVA

C-1. MAIN EFFECT OF TRANSITION STUDENT PILOT

ESTIMATES OF MEANS

		NOSP6 1	NOSP7 2	TOTAL 3
TOTCOM	2	557.9749	496.6844	527.3297
TXCOM	3	74.4063	84.2688	79.3375
UIPCOM	4	30.2937	35.5969	32.9453

ONE WAY ANALYSIS OF VARIANCE FOR VARIABLE TOTCOM
****

ANALYSIS OF VARIANCE TABLE

SOURCE OF VAR	D.F	SUM OF SQ	MEAN SQ	F-VALUE	P-VALUE
EQ OF CELL MEANS	1	60104.520	60104.5	123.716	.0000
ERROR	62	3316.213	53.49		

ONE WAY ANALYSIS OF VARIANCE FOR VARIABLE TXCOM
****

ANALYSIS OF VARIANCE TABLE

SOURCE OF VAR	D.F	SUM OF SQ	MEAN SQ	F-VALUE	P-VALUE
EQ OF CELL MEANS	1	1556.3035	1556.30	37.5569	.0000
ERROR	62	2569.1875	41.4385		

ONE WAY ANALYSIS OF VARIANCE FOR VARIABLE UIPCOM
****

ANALYSIS OF VARIANCE TABLE

SOURCE OF VAR	D.F	SUM OF SQ	MEAN SQ	F-VALUE	P-VALUE
EQ OF CELL MEANS	1	449.9696	449.9696	25.3382	.0000
ERROR	62	1101.0286	17.7585		

C-2. MAIN EFFECTS OF F-16C

ESTIMATES OF MEANS

		F16C2 1	F16C3 2	TOTAL 3
TOTCOM	2	527.7094	526.9500	527.3297
TXCOM	3	79.2094	79.4656	79.3375
UIPCOM	4	32.2625	33.6281	32.9453

ONE WAY ANALYSIS OF VARIANCE FOR VARIABLE TOTCOM

ANALYSIS OF VARIANCE TABLE

SOURCE OF VAR	D.F	SUM OF SQ	MEAN SQ	F-VALUE	P-VALUE
EQ OF CELL MEANS	1	9.2285	9.2285	.0090	.9246
ERROR	62	63411.625	1022.77		

ONE WAY ANALYSIS OF VARIANCE FOR VARIABLE TXCOM

ANALYSIS OF VARIANCE TABLE

SOURCE OF VAR	D.F	SUM OF SQ	MEAN SQ	F-VALUE	P-VALUE
EQ OF CELL MEANS	1	1.0507	1.0507	.0158	.9004
ERROR	62	4124.4355	66.5232		

ONE WAY ANALYSIS OF VARIANCE FOR VARIABLE UIPCOM

ANALYSIS OF VARIANCE TABLE

SOURCE OF VAR	D.F	SUM OF SQ	MEAN SQ	F-VALUE	P-VALUE
EQ OF CELL MEANS	1	29.8392	29.8392	1.2162	.2744
ERROR	62	1521.1597	24.5348		

C-3. MAIN EFFECTS OF F-16D

ESTIMATES OF MEANS

		F16D6 1	F16D5 2	TOTAL 3
TOTCOM	2	524.1188	530.5406	527.3297
TXCOM	3	75.7625	82.9125	79.3375
UIPCOM	4	31.0625	34.8281	32.9453

ONE WAY ANALYSIS OF VARIANCE FOR VARIABLE TOTCOM

ANALYSIS OF VARIANCE TABLE

SOURCE OF VAR	D.F	SUM OF SQ	MEAN SQ	F-VALUE	P-VALUE
EQ OF CELL MEANS	1	659.8477	659.848	.6518	.4225
ERROR	62	62761.12	1012.28		

ONE WAY ANALYSIS OF VARIANCE FOR VARIABLE TXCOM

ANALYSIS OF VARIANCE TABLE

SOURCE OF VAR	D.F	SUM OF SQ	MEAN SQ	F-VALUE	P-VALUE
EQ OF CELL MEANS	1	817.9604	817.9604	15.3328	.0002
ERROR	62	3307.5308	53.3473		

ONE WAY ANALYSIS OF VARIANCE FOR VARIABLE UIPCOM

ANALYSIS OF VARIANCE TABLE

SOURCE OF VAR	D.F	SUM OF SQ	MEAN SQ	F-VALUE	P-VALUE
EQ OF CELL MEANS	1	226.8780	226.878	10.6232	.0018
ERROR	62	1324.1202	21.3568		

C-4. MAIN EFFECTS OF AIRCRAFT FAILURE RATE

ESTIMATES OF MEANS

		LOFR 1	HIFR 2	TOTAL 3
TOTCOM	2	522.1719	532.4875	527.3297
TXCOM	3	74.6250	84.0500	79.3375
UIPCOM	4	29.8531	36.0375	32.9453

ONE WAY ANALYSIS OF VARIANCE FOR VARIABLE TOTCOM

ANALYSIS OF VARIANCE TABLE

SOURCE OF VAR	D.F	SUM OF SQ	MEAN SQ	F-VALUE	P-VALUE
EQ OF CELL MEANS	1	1702.6100	1702.61	1.7104	.1958
ERROR	62	61718.277	995.456		

ONE WAY ANALYSIS OF VARIANCE FOR VARIABLE TXCOM

ANALYSIS OF VARIANCE TABLE

SOURCE OF VAR	D.F	SUM OF SQ	MEAN SQ	F-VALUE	P-VALUE
EQ OF CELL MEANS	1	1421.2864	1421.286	32.5863	.0000
ERROR	62	2704.1987	43.6161		

ONE WAY ANALYSIS OF VARIANCE FOR VARIABLE UIPCOM

ANALYSIS OF VARIANCE TABLE

SOURCE OF VAR	D.F	SUM OF SQ	MEAN SQ	F-VALUE	P-VALUE
EQ OF CELL MEANS	1	611.9446	611.945	40.4029	.0000
ERROR	62	939.0545	15.1460		

Appendix D. Statistical Results for MANOVA

D-1. SUMMARY STATISTICS FOR VARIATE(S):

VARIATE	COUNT	MEAN	STDERROR	STD_DEV	MAXIMUM	MINIMUM
TOTCOM	64	527.3	3.966	31.73	568.4	483.4
TXCOM	64	79.34	1.012	8.092	96.20	67.60
UIPCOM	64	32.95	.6202	4.962	48.50	25.70

D-2. MARGINAL STATISTICS

FACTOR	LEVEL	VARIATE	MEAN	STDERR	STDDEV	MAX	MIN
NOSP	NOSP6	TOTCOM	558.0	.8131	4.600	568.4	549.6
		TXCOM	74.41	.8217	4.648	83.50	67.60
		UIPCOM	30.29	.5018	2.839	34.90	25.70
	NOSP7	TOTCOM	496.7	1.638	9.264	510.1	483.4
		TXCOM	84.27	1.384	7.827	96.20	71.40
		UIPCOM	35.60	.9263	5.240	48.50	27.80
F16C	F16C2	TOTCOM	527.7	5.733	32.43	568.4	483.4
		TXCOM	79.21	1.385	7.835	94.30	68.10
		UIPCOM	32.26	.7686	4.348	40.80	25.70
	F16C3	TOTCOM	527.0	5.573	31.52	568.4	488.1
		TXCOM	79.47	1.496	8.465	96.20	67.60
		UIPCOM	33.63	.9709	5.492	48.50	26.40
F16D	F16D6	TOTCOM	524.1	5.616	31.77	561.4	483.4
		TXCOM	75.76	1.172	6.632	88.50	67.60
		UIPCOM	31.06	.7068	3.998	39.10	25.70
	F16D5	TOTCOM	530.5	5.633	31.87	568.4	488.1
		TXCOM	82.91	1.400	7.919	96.20	71.70
		UIPCOM	34.83	.9139	5.170	48.50	28.50
ACFR	LOFR	TOTCOM	522.2	6.094	34.47	561.2	483.4
		TXCOM	74.62	.9200	5.204	84.90	67.60
		UIPCOM	29.85	.4667	2.640	35.30	25.70
	HIFR	TOTCOM	532.5	5.008	28.33	568.4	498.7
		TXCOM	84.05	1.371	7.756	96.20	71.90
		UIPCOM	36.04	.8537	4.829	48.50	27.60

D-3. CELL STATISTICS

==

FACTOR	LEVEL
NOSP	NOSP6

==>

FACTOR	LEVEL
F16C	F16C2

====>

FACTOR	LEVEL
F16D	F16D6

======>

FACTOR	LEVEL	VARIATE	MEAN	STDERR	STDDEV	MAX	MIN
ACFR	LOFR	TOTCOM	554.3	.8199	1.640	556.2	552.2
		TXCOM	69.35	.5560	1.112	70.70	68.10
		UIPCOM	26.55	.3069	.6137	27.00	25.70
	HIFR	TOTCOM	557.4	1.967	3.934	561.4	552.4
		TXCOM	74.27	.9295	1.859	75.90	71.90
		UIPCOM	29.28	.7409	1.482	31.20	27.60

====>

FACTOR	LEVEL
F16D	F16D5

======>

FACTOR	LEVEL	VARIATE	MEAN	STDERR	STDDEV	MAX	MIN
ACFR	LOFR	TOTCOM	558.5	.9883	1.977	561.2	556.6
		TXCOM	72.35	.3122	.6245	73.20	71.70
		UIPCOM	29.50	.6055	1.211	31.30	28.70
	HIFR	TOTCOM	565.0	1.215	2.431	568.4	562.6
		TXCOM	81.30	.7583	1.517	83.20	79.50
		UIPCOM	33.72	.6142	1.228	34.80	32.30

==>

FACTOR	LEVEL
F16C	F16C3

====>

FACTOR	LEVEL
F16D	F16D6

======>

FACTOR	LEVEL	VARIATE	MEAN	STDERR	STDDEV	MAX	MIN
ACFR	LOFR	TOTCOM	553.7	1.415	2.830	556.2	549.6
		TXCOM	69.13	.5721	1.144	70.10	67.60
		UIPCOM	27.40	.4103	.8206	28.40	26.40
	HIFR	TOTCOM	554.0	.7122	1.424	555.4	552.2
		TXCOM	73.50	.4655	.9310	74.80	72.60
		UIPCOM	32.58	.4956	.9912	33.90	31.60

====>
FACTOR LEVEL
F16D F16D5

======>

FACTOR	LEVEL	VARIATE	MEAN	STDERR	STDDEV	MAX	MIN
ACFR	LOFR	TOTCOM	557.3	.8712	1.742	559.6	555.5
		TXCOM	73.80	.7012	1.402	75.60	72.20
		UIPCOM	29.37	.5105	1.021	30.80	28.50
	HIFR	TOTCOM	563.7	.8451	1.690	565.4	561.4
		TXCOM	81.55	.6764	1.353	83.50	80.40
		UIPCOM	33.95	.5838	1.168	34.90	32.40

==

FACTOR LEVEL
NOSP NOSP7
==>
FACTOR LEVEL
F16C F16C2
====>
FACTOR LEVEL
F16D F16D6
======>

FACTOR	LEVEL	VARIATE	MEAN	STDERR	STDDEV	MAX	MIN
ACFR	LOFR	TOTCOM	485.5	.8431	1.686	487.5	483.4
		TXCOM	74.77	.7793	1.559	76.60	73.20
		UIPCOM	29.38	.6775	1.355	30.90	28.00
	HIFR	TOTCOM	502.2	.3750	.7500	503.2	501.5
		TXCOM	86.65	1.178	2.356	88.50	83.20
		UIPCOM	36.70	.9806	1.961	39.10	35.00

====>
FACTOR LEVEL
F16D F16D5
======>

FACTOR	LEVEL	VARIATE	MEAN	STDERR	STDDEV	MAX	MIN
ACFR	LOFR	TOTCOM	490.6	1.271	2.542	494.2	488.4
		TXCOM	81.38	1.178	2.356	83.80	78.20
		UIPCOM	33.22	.6169	1.234	34.10	31.40
	HIFR	TOTCOM	508.3	.4031	.8062	509.2	507.4
		TXCOM	93.60	.3240	.6481	94.30	92.80
		UIPCOM	39.75	.4406	.8813	40.80	38.70

==>
FACTOR LEVEL
F16C F16C3
====>
FACTOR LEVEL
F16D F16D6
======>

FACTOR	LEVEL	VARIATE	MEAN	STDERR	STDDEV	MAX	MIN
ACFR	LOFR	TOTCOM	485.9	.7432	1.486	487.6	484.2
		TXCOM	72.43	.5105	1.021	73.80	71.40
		UIPCOM	29.50	.8898	1.780	31.90	27.80
	HIFR	TOTCOM	500.1	.6124	1.225	501.4	498.7
		TXCOM	86.00	.5672	1.134	87.20	84.80
		UIPCOM	37.12	.5764	1.153	38.40	36.10

====>
FACTOR LEVEL
F16D F16D5
======>

FACTOR	LEVEL	VARIATE	MEAN	STDERR	STDDEV	MAX	MIN
ACFR	LOFR	TOTCOM	491.7	2.058	4.116	496.6	488.1
		TXCOM	83.80	.5492	1.098	84.90	82.40
		UIPCOM	33.90	.5958	1.192	35.30	32.40
	HIFR	TOTCOM	509.3	.3010	.6021	510.1	508.8
		TXCOM	95.53	.3038	.6076	96.20	94.80
		UIPCOM	45.20	1.287	2.574	48.50	42.30

D-4. DESIGN TYPES OF FACTORIAL ANALYSIS

```
DESIGN  TYPE IS BETWEEN, CONTRAST.  MODEL.
  CODE IS CONST.  NAME IS 'OVALL: GRAND MEAN'./

DESIGN  FACTOR IS NOSP.
  CODE IS EFFECT.  NAME IS 'N: NOSP'./

DESIGN  FACTOR IS F16C.
  CODE IS EFFECT.  NAME IS 'F: F16C'./

DESIGN  FACTOR IS F16D.
  CODE IS EFFECT.  NAME IS 'B: F16D'./

DESIGN  FACTOR IS ACFR.
  CODE IS EFFECT.  NAME IS 'A: ACFR'./

INTERACT EFFECTS ARE N,F.
        NAME IS NF./

INTERACT EFFECTS ARE N,B.
        NAME IS NB./

INTERACT EFFECTS ARE N,A.
        NAME IS NA./

INTERACT EFFECTS ARE F,B.
        NAME IS FB./

INTERACT EFFECTS ARE F,A.
        NAME IS FA./

INTERACT EFFECTS ARE B,A.
        NAME IS BA./

INTERACT EFFECTS ARE NF,B.
        NAME IS NFB./

INTERACT EFFECTS ARE NF,A.
        NAME IS NFA./

INTERACT EFFECTS ARE NB,A.
        NAME IS NBA./

INTERACT EFFECTS ARE FB,A.
        NAME IS FBA./

INTERACT EFFECTS ARE NFB,A.
        NAME IS NFBA./
```

D-5. ESTIMATES FOR BETWEEN-GROUPS DESIGN

PARAMETERS (PHI). ROWS: PARAMETERS; COLUMNS: VARIABLES (WITHIN-DESIGN CELLS).

EFFEC: OVALL: GRAND MEAN

1	2	3
527.32969	79.337500	32.945312

EFFECT: N: NOSP

1	2	3
30.645313	-4.9312506	-2.6515624

EFFECT: F: F16C

1	2	3
.37968779	-.12812543	-.68281257

EFFECT: B: F16D

1	2	3
-3.2109323	-3.5750003	-1.8828124

EFFECT: A: ACFR

1	2	3
-5.1578135	-4.7125003	-3.0921876

EFFECT: NF

1	2	3
.44531298	.40624857e-01	.15156251

EFFECT: NB

1	2	3
.60942173e-01	.73125029	.53906244

EFFECT: NA

1	2	3
3.1328082	1.4624999	1.0046875

EFFECT: FB

1	2	3
.33906412	.62812495	.95312595e-01

EFFECT: FA

1	2	3
-.34531260	-.34375191e-01	.49218762

EFFECT: BA

1	2	3
.86406469	.36875033	.23593760

```
EFFECT:  NFB
         1                2                3
    -.15156031      -.29062486      -.60156244

EFFECT:  NFA
         1                2                3
    -.17186642e-01 -.18437481      -.14218730

EFFECT:  NBA
         1                2                3
     .32343912       .55624986      -.12343758

EFFECT:  FBA
         1                2                3
    -.31093931       .17812490      -.14843750

EFFECT:  NFBA
         1                2                3
    -.15645027e-02 -.96875191e-01  .41093737
```

D-6. TEST STATISTICS

```
EFFECT   VARIATE    STATISTIC             F         DF        P
--------------------------------------------------------------------
 OVALL: GRAND MEAN
        -ALL----
                  S= 1,T= 3,DFH= 1,DFE= 48
                  HT EVALS= .99998817
                  HE EVALS= 84525.073
                  TSQ=   *.405720e+07 ********  3, 46   .0000
 * ABOVE STATISTIC POSSIBLY ACCURATE TO ONLY  4 DIGITS.
 NUMERICALLY CONSERVATIVE F:          ********  3, 46   .0000
        TOTCOM
                  SS=   .177969e+08
                  MS=   .177969e+08   ********  1, 48   .0000
        TXCOM
                  SS=        402844.
                  MS=        402844.  ********  1, 48   .0000
        UIPCOM
                  SS=        69465.2
                  MS=        69465.2  36883.16  1, 48   .0000

 N: NOSP
        -ALL----
                  S= 1,T= 3,DFH= 1,DFE= 48
                  HT EVALS=  .99766360
                  HE EVALS=  427.00884
                  TSQ=       20496.4   6547.47  3, 46   .0000
        TOTCOM
                  SS=        60104.7
                  MS=        60104.7    746.78  1, 48   .0000
        TXCOM
                  SS=        1556.30
                  MS=        1556.30    797.89  1, 48   .0000
        UIPCOM
                  SS=        449.970
                  MS=        449.970    238.92  1, 48   .0000
 F: F16C
        -ALL----
                  S= 1,T= 3,DFH= 1,DFE= 48
                  HT EVALS=  .27779769
                  HE EVALS=  .38465355
                  TSQ=       18.4634      5.90  3, 46   .0017
        TOTCOM
                  SS=        9.22642
                  MS=        9.22642      1.96  1, 48   .1683
        TXCOM
                  SS=        1.05063
                  MS=        1.05063       .54  1, 48   .4666
        UIPCOM
```

```
                SS=         29.8389
                MS=         29.8389      15.84  1, 48    .0002
B: F16D
        -ALL----
                S= 1,T= 3,DFH= 1,DFE= 48
                HT EVALS=  .90921037
                HE EVALS=  10.014473
                TSQ=        480.695     153.56  3, 46    .0000
        TOTCOM
                SS=         659.846
                MS=         659.846     139.94  1, 48    .0000
        TXCOM
                SS=         817.960
                MS=         817.960     419.35  1, 48    .0000
        UIPCOM
                SS=         226.879
                MS=         226.879     120.46  1, 48    .0000
A: ACFR
        -ALL----
                S= 1,T= 3,DFH= 1,DFE= 48
                HT EVALS=  .95289417
                HE EVALS=  20.228796
                TSQ=        970.982     310.17  3, 46    .0000
        TOTCOM
                SS=         1702.59
                MS=         1702.59     361.08  1, 48    .0000
        TXCOM
                SS=         1421.29
                MS=         1421.29     728.67  1, 48    .0000
        UIPCOM
                SS=         611.944
                MS=         611.944     324.92  1, 48    .0000
NF
        -ALL----
                S= 1,T= 3,DFH= 1,DFE= 48
                HT EVALS=  .07692595
                HE EVALS=  .83336709e-01
                TSQ=        4.00016       1.28  3, 46    .2931
        TOTCOM
                SS=         12.6914
                MS=         12.6914       2.69  1, 48    .1074
        TXCOM
                SS=         .105624
                MS=         .105624        .05  1, 48    .8170
        UIPCOM
                SS=         1.47016
                MS=         1.47016        .78  1, 48    .3814
NB
        -ALL----
                S= 1,T= 3,DFH= 1,DFE= 48
                HT EVALS=  .34940890
                HE EVALS=  .53706375
```

```
            TSQ=        25.7791         8.23   3, 46    .0002
      TOTCOM
            SS=         .237693
            MS=         .237693          .05   1, 48    .8233
      TXCOM
            SS=         34.2225
            MS=         34.2225        17.55   1, 48    .0001
      UIPCOM
            SS=         18.5977
            MS=         18.5977         9.87   1, 48    .0029
NA
      -ALL----
            S= 1,T= 3,DFH= 1,DFE= 48
            HT EVALS=   .78071704
            HE EVALS=   3.5603178
            TSQ=        170.895        54.59   3, 46    .0000
      TOTCOM
            SS=         628.127
            MS=         628.127       133.21   1, 48    .0000
      TXCOM
            SS=         136.890
            MS=         136.890        70.18   1, 48    .0000
      UIPCOM
            SS=         64.6014
            MS=         64.6014        34.30   1, 48    .0000
FB
      -ALL----
            S= 1,T= 3,DFH= 1,DFE= 48
            HT EVALS=   .21506468
            HE EVALS=   .27399032
            TSQ=        13.1515         4.20   3, 46    .0104
      TOTCOM
            SS=         7.35773
            MS=         7.35773         1.56   1, 48    .2177
      TXCOM
            SS=         25.2506
            MS=         25.2506        12.95   1, 48    .0008
      UIPCOM
            SS=         .581407
            MS=         .581407          .31   1, 48    .5811
FA
      -ALL----
            S= 1,T= 3,DFH= 1,DFE= 48
            HT EVALS=   .17299760
            HE EVALS=   .20918633
            TSQ=        10.0409         3.21   3, 46    .0316
      TOTCOM
            SS=         7.63141
            MS=         7.63141         1.62   1, 48    .2094
      TXCOM
            SS=         .756258e-01
            MS=         .756258e-01      .04   1, 48    .8447
```

```
     UIPCOM
            SS=          15.5039
            MS=          15.5039          8.23  1, 48    .0061
BA
     -ALL----
            S= 1,T= 3,DFH= 1,DFE= 48
            HT EVALS=  .20144759
            HE EVALS=  .25226596
            TSQ=         12.1088          3.87  3, 46    .0151
     TOTCOM
            SS=          47.7829
            MS=          47.7829         10.13  1, 48    .0026
     TXCOM
            SS=          8.70252
            MS=          8.70252          4.46  1, 48    .0399
     UIPCOM
            SS=          3.56266
            MS=          3.56266          1.89  1, 48    .1754
NFB
     -ALL----
            S= 1,T= 3,DFH= 1,DFE= 48
            HT EVALS=  .21632653
            HE EVALS=  .27604167
            TSQ=         13.2500          4.23  3, 46    .0101
     TOTCOM
            SS=          1.47011
            MS=          1.47011           .31  1, 48    .5792
     TXCOM
            SS=          5.40562
            MS=          5.40562          2.77  1, 48    .1025
     UIPCOM
            SS=          23.1602
            MS=          23.1602         12.30  1, 48    .0010
NFA
     -ALL----
            S= 1,T= 3,DFH= 1,DFE= 48
            HT EVALS=  .03373078
            HE EVALS=  .34908259e-01
            TSQ=         1.67560           .54  3, 46    .6604
     TOTCOM
            SS=          .189044e-01
            MS=          .189044e-01       .00  1, 48    .9498
     TXCOM
            SS=          2.17562
            MS=          2.17562          1.12  1, 48    .2962
     UIPCOM
            SS=          1.29390
            MS=          1.29390           .69  1, 48    .4113
NBA
     -ALL----
            S= 1,T= 3,DFH= 1,DFE= 48
            HT EVALS=  .20314177
```

```
                  HE EVALS=  .25492837
                  TSQ=        12.2366        3.91  3, 46   .0144
           TOTCOM
                  SS=         6.69522
                  MS=         6.69522        1.42  1, 48   .2393
           TXCOM
                  SS=         19.8025
                  MS=         19.8025       10.15  1, 48   .0025
           UIPCOM
                  SS=         .975158
                  MS=         .975158         .52  1, 48   .4753
  FBA
           -ALL----
                  S= 1,T= 3,DFH= 1,DFE= 48
                  HT EVALS=  .10776842
                  HE EVALS=  .12078526
                  TSQ=        5.79769        1.85  3, 46   .1510
           TOTCOM
                  SS=         6.18773
                  MS=         6.18773        1.31  1, 48   .2577
           TXCOM
                  SS=         2.03062
                  MS=         2.03062        1.04  1, 48   .3127
           UIPCOM
                  SS=         1.41016
                  MS=         1.41016         .75  1, 48   .3912
  NFBA
           -ALL----
                  S= 1,T= 3,DFH= 1,DFE= 48
                  HT EVALS=  .12883351
                  HE EVALS=  .14788621
                  TSQ=        7.09854        2.27  3, 46   .0932
           TOTCOM
                  SS=         .156651e-03
                  MS=         .156651e-03     .00  1, 48   .9954
           TXCOM
                  SS=         .600627
                  MS=         .600627         .31  1, 48   .5815
           UIPCOM
                  SS=         10.8076
                  MS=         10.8076        5.74  1, 48   .0205

  ERROR
           TOTCOM
                  SS=         226.33343
                  MS=         4.7152797
           TXCOM
                  SS=         93.625016
                  MS=         1.9505212
           UIPCOM
                  SS=         90.402486
                  MS=         1.8833851
```

Appendix E. Statistical Results for Sensitivity Analysis

E-1. SENSITIVITY OF TRANSITION STUDENT PILOT

ESTIMATES OF MEANS

		NOSP6 1	NOSP7 2	TOTAL 3
TOTCOM	2	554.3500	485.4500	519.9000
TXCOM	3	69.3500	74.7750	72.0625
UIPCOM	4	26.5500	29.3750	27.9625

ONE WAY ANALYSIS OF VARIANCE FOR VARIABLE TOTCOM
****

ANALYSIS OF VARIANCE TABLE

SOURCE OF VAR	D.F	SUM OF SQ	MEAN SQ	F-VALUE	P-VALUE
EQ OF CELL MEANS	1	9494.4268	9494.43	27.6042	.0000
ERROR	6	16.6199	2.7700		

ONE WAY ANALYSIS OF VARIANCE FOR VARIABLE TXCOM
****

ANALYSIS OF VARIANCE TABLE

SOURCE OF VAR	D.F	SUM OF SQ	MEAN SQ	F-VALUE	P-VALUE
EQ OF CELL MEANS	1	58.8613	58.8613	32.1135	.0013
ERROR	6	10.9975	1.8329		

ONE WAY ANALYSIS OF VARIANCE FOR VARIABLE UIPCOM
****

ANALYSIS OF VARIANCE TABLE

SOURCE OF VAR	D.F	SUM OF SQ	MEAN SQ	F-VALUE	P-VALUE
EQ OF CELL MEANS	1	15.9613	15.9613	14.4283	.0090
ERROR	6	6.6375	1.1063		

E-2. SENSTIVITY OF F-16D

ESTIMATES OF MEANS

		F16D6 1	F16D5 2	TOTAL 3
TOTCOM	2	554.3500	558.5000	556.4250
TXCOM	3	69.3500	72.3500	70.8500
UIPCOM	4	26.5500	29.5000	28.0250

ONE WAY ANALYSIS OF VARIANCE FOR VARIABLE TOTCOM
****

ANALYSIS OF VARIANCE TABLE

SOURCE OF VAR	D.F	SUM OF SQ	MEAN SQ	F-VALUE	P-VALUE
EQ OF CELL MEANS	1	34.4444	34.4444	10.4324	.0179
ERROR	6	19.8101	3.3017		

ONE WAY ANALYSIS OF VARIANCE FOR VARIABLE TXCOM
****

ANALYSIS OF VARIANCE TABLE

SOURCE OF VAR	D.F	SUM OF SQ	MEAN SQ	F-VALUE	P-VALUE
EQ OF CELL MEANS	1	18.0000	18.0000	22.1312	.0033
ERROR	6	4.8800	.8133		

ONE WAY ANALYSIS OF VARIANCE FOR VARIABLE UIPCOM
****

ANALYSIS OF VARIANCE TABLE

SOURCE OF VAR	D.F	SUM OF SQ	MEAN SQ	F-VALUE	P-VALUE
EQ OF CELL MEANS	1	17.4050	17.4050	18.8843	.0048
ERROR	6	5.5300	.9217		

E-3. SENSITIVITY OF AIRCRAFT FAILUR RATE

ESTIMATES OF MEANS

		LOW 1	MEDM 2	HIGH 3	TOTAL 4
TOTCOM	2	554.3250	556.0250	557.3500	555.9001
TXCOM	3	69.3500	72.7250	74.2750	72.1167
UIPCOM	4	26.5500	29.1250	29.2750	28.3167

ONE WAY ANALYSIS OF VARIANCE FOR VARIABLE TOTCOM
****

ANALYSIS OF VARIANCE TABLE

SOURCE OF VAR	D.F	SUM OF SQ	MEAN SQ	F-VALUE	P-VALUE
EQ OF CELL MEANS	2	18.3953	9.1976	.9994	.4055
ERROR	9	82.8256	9.2028		

ONE WAY ANALYSIS OF VARIANCE FOR VARIABLE TXCOM
****

ANALYSIS OF VARIANCE TABLE

SOURCE OF VAR	D.F	SUM OF SQ	MEAN SQ	F-VALUE	P-VALUE
EQ OF CELL MEANS	2	50.7317	25.3659	11.2654	.0035
ERROR	9	20.2650	2.2517		

ONE WAY ANALYSIS OF VARIANCE FOR VARIABLE UIPCOM
****

ANALYSIS OF VARIANCE TABLE

SOURCE OF VAR	D.F	SUM OF SQ	MEAN SQ	F-VALUE	P-VALUE
EQ OF CELL MEANS	2	18.7717	9.3858	8.9247	.0073
ERROR	9	9.4650	1.0517		

E-4. SENSITIVITY OF MISSION EFFECTIVENESS RATE

ESTIMATES OF MEANS

		LOW 1	MEDM 2	HIGH 3	TOTAL 4
TOTCOM	2	551.5250	554.3250	558.5500	554.8000
TXCOM	3	66.8000	69.3500	77.0250	71.0583
UIPCOM	4	26.9250	26.5500	33.4750	28.9833

ONE WAY ANALYSIS OF VARIANCE FOR VARIABLE TOTCOM

ANALYSIS OF VARIANCE TABLE

SOURCE OF VAR	D.F	SUM OF SQ	MEAN SQ	F-VALUE	P-VALUE
EQ OF CELL MEANS	2	100.0558	50.0279	11.6874	.0031
ERROR	9	38.5245	4.2805		

ONE WAY ANALYSIS OF VARIANCE FOR VARIABLE TXCOM

ANALYSIS OF VARIANCE TABLE

SOURCE OF VAR	D.F	SUM OF SQ	MEAN SQ	F-VALUE	P-VALUE
EQ OF CELL MEANS	2	226.6116	113.3058	140.5105	.0000
ERROR	9	7.2575	.8064		

ONE WAY ANALYSIS OF VARIANCE FOR VARIABLE UIPCOM

ANALYSIS OF VARIANCE TABLE

SOURCE OF VAR	D.F	SUM OF SQ	MEAN SQ	F-VALUE	P-VALUE
EQ OF CELL MEANS	2	121.3318	60.6659	110.4131	.0000
ERROR	9	4.9450	.5494		

Appendix F. F-16 Pilot Training Model (SLAM Code)

```
GEN,YLEE,TRTRN,8/1/85,4,,N;
LIMITS,35,10,500;
PRIORITY/1,LVF(2)/NCLNR,LVF(1);
PRIORITY/2,LVF(2)/NCLNR,LVF(1);
PRIORITY/3,LVF(2)/NCLNR,LVF(1);
PRIORITY/4,LVF(2)/NCLNR,LVF(1);
PRIORITY/6,LVF(2)/NCLNR,LVF(1);
PRIORITY/7,LVF(2)/NCLNR,LVF(1);
PRIORITY/8,LVF(2)/NCLNR,LVF(1);
INTLC,XX(1)=8;              NUBBER OF CLASSES
INTLC,XX(2)=6;              TRANSITION(TX) STUDENT PILOTS(SP)
INTLC,XX(3)=2;              UPGRADING INSTRUCTOR PILOTS(UIP)
INTLC,XX(4)=0,XX(5)=0,XX(6)=0,XX(7)=0,XX(8)=0,XX(9)=0;
INTLC,XX(10)=0,XX(11)=0,XX(12)=0,XX(13)=0,XX(15)=0;
INTLC,XX(16)=0,XX(17)=0,XX(18)=0,XX(19)=0,XX(20)=0;
INTLC,XX(31)=0.025,XX(32)=0.975;
;                           PREFLIGHT CHECK ACFT FAIL RATE
INTLC,XX(33)=0.067,XX(34)=0.933; GROUND ABORT RATE
INTLC,XX(35)=0.033,XX(36)=0.967;
;                           POSTFLIGHT CHECK ACFT FAIL RATE
INTLC,XX(80)=0.17;          MISSION EFFECTIVENESS RATE
;
;
NETWORK;
      RESOURCE/IP(4),1/F16C(0),2/F16D(6),3/AREA(3),4;
;                           INITIAL IP,F16C,F16D, AREA
      GATE/WX,OPEN,5/DAY,OPEN,6,8/ACTR,CLOSE,7;
;                           WX,DAY,ACADEMIC(ACAD) GATE
;
      CREATE,69,69,,6;  CREATE 2 UIPs EVERY 3 MONTHS
      GOON;
      ACT,,,UIPT;
      ACT,,,UIPT;
      ACT,,,UALT;           DUMMY ENTITY
;
      CREATE,69,,,8;        CREATE 6 SPs EVERY 3 MONTHS
      GOON;
      ACT,,,TXTR;
      ACT,,,TXTR;
      ACT,,,TXTR;
      ACT,,,TXTR;
      ACT,,,TXTR;
      ACT,,,TXTR;
      ACT,,,TALT;           DUMMY ENTITY
;
TALT  ALTER,IP/-1;          CHANGING 1 IP FOR ACADEMIC TRN
      ASSIGN,XX(12)=XX(12)-1;   CLASS NUMBER
      ACT,19,,INIP;         GROUND ACADEMIC TRAINING(TRN)
      ACT;
      GOON,1;
```

```
       ACT,,XX(12).EQ.2,CAC1; 2nd CLASS
       ACT,,XX(12).EQ.3,CAC2; 3rd CLASS
       ACT,,XX(12).EQ.8,CAC3; 8th CLASS (AFTER UIP COMPLETE)
INIP   ALTER,IP/1;                   RETURN 1 IP AFTER ACADEMICS
       TERM;
;
CAC1   GOON;                FOR CHANGING AIRCRAFT
       ACT,23;              AFTER 1st F-16C ARRIVAL
       ALTER,F16C/2;        INCREASE 2 F-16Cs
       TERM;
;
CAC2   GOON;                FOR CHANGING AIRCRAFT
       ACT,46;              AFTER 2nd F-16Cs ARRIVAL
       ALTER,F16C/2;        INCREASE 2 F-16Cs
       ALTER,F16D/-2;       DECREASE 2 F-16Ds
       TERM;
;
CAC3   ALTER,F16C/-2;       DECREASE 2 F-16Cs
       TERM;
;
TXTR   GOON;
       ACT,19;              GROUND ACADEMIC TRN

ASSIGN,ATRIB(1)=Ø,ATRIB(2)=TNOW,ATRIB(3)=9Ø,ATRIB(7)=Ø,
        ATRIB(8)=XX(12),ATRIB(9)=1;
;
;       ATRIB(1): SORTIES FLOWN
;       ATRIB(2): STARTING DAY OF FLYING
;       ATRIB(3): ACADEMICS
;       ATRIB(4): FOR RELEASING AREA IN AIRCRAFT SUBROUTINE
;       ATRIB(5): MISSION (MSN) TYPE INDEX
;       ATRIB(6): INDEX OF AREA DRAWN(1) OR NOT(Ø)
;       ATRIB(7): DAILY SORTIE FLOWN
;       ATRIB(8): CLASS NUMBER
;       ATRIB(9): INDEX OF TX TRN(1) OR UIP TRN(2)
;
CONT   GOON,1;
       ACT,,ATRIB(1).GE.22.AND.ATRIB(3).GE.225,COLL;
                            COMPLETE FLY & ACAD
       ACT;                 NOT COMPLETE FLY & ACAD, CONTINUE
       ASSIGN,ATRIB(5)=Ø,1;  RESET MSN TYPE INDEX
       GOON,1;
       ACT,,NNGAT(DAY).EQ.Ø,ASPD;IF NIGHT
       ACT;
       ASSIGN,ATRIB(7)=Ø;  RESET SORTIE FLOWN PER DAY
ASPD   AWAIT(6),DAY,1;      WAITING DAYLIGHT HOURS
       ACT,,NNGAT(WX).EQ.1.AND.ATRIB(3).LE.225,ACAD;
;                           WX BAD,ACADEMICS
       ACT,,NNGAT(WX).EQ.Ø.AND.NNRSC(IP).GE.1.AND.
            NNRSC(F16D).GE.1.AND.NNRSC(AREA).GE.1.AND.
            ATRIB(7).EQ.Ø,TFLY;
;                        IP,ACFT,AREA AVAILABLE & NOT COMPLETED
```

```
        ACT,1/24,,CONT; ELSE, DELAY 1 HRS & CONTINUE
;
;       CHECK ACADEMICS PREREQUISITES COMPLETED
;
TFLY    GOON,1;
        ACT,,ATRIB(1).GE.3.AND.ATRIB(1).LE.5.AND.
             ATRIB(3).LE.140,ACAD;
        ACT,,ATRIB(1).GE.7.AND.ATRIB(1).LE.9.AND.
             ATRIB(3).LE.170,ACAD;
        ACT,,ATRIB(1).GE.11.AND.ATRIB(1).LE.13.AND.
             ATRIB(3).LE.210,ACAD;
        ACT,,ATRIB(1).GT.16.AND.ATRIB(1).LE.18.AND.
             ATRIB(3).LE.225,ACAD;
        ACT;
;
;       ASSIGN # OF SPs LEFT FOR MISSIONS REQUIRING 2 SPs
;
        ASSIGN,XX(21)=XX(2)*ATRIB(8)-NNCNT(33)-NNCNT(46),
               XX(22)=XX(2)*ATRIB(8)-NNCNT(34)-NNCNT(47),
               XX(23)=XX(2)*ATRIB(8)-NNCNT(42)-NNCNT(43)-
                      NNCNT(63),
               XX(24)=XX(2)*ATRIB(8)-NNCNT(40)-NNCNT(44)-
                      NNCNT(64);
        ASSIGN,XX(25)=XX(2)*ATRIB(8)-NNCNT(41)-NNCNT(45)-
                      NNCNT(65),
               XX(26)=XX(2)*ATRIB(8)-NNCNT(35)-NNCNT(56),
               XX(27)=XX(2)*ATRIB(8)-NNCNT(36)-NNCNT(58),
               XX(28)=XX(2)*ATRIB(8)-NNCNT(37)-NNCNT(61),1;
;
;       DETERMINE MISSION TYPE ACCORDING TO # OF SPs,
;       # OF IPs, # AND TYPE OF AIRCRAFT
;
        ACT,,ATRIB(1).EQ.0,TYP1;
        ACT,,ATRIB(1).EQ.1,TYP1;
        ACT,,ATRIB(1).EQ.2.AND.XX(21).NE.1,TYP3;
        ACT,,ATRIB(1).EQ.2.AND.XX(21).EQ.1,TYP8;
        ACT,,ATRIB(1).EQ.3.AND.XX(22).NE.1,TYP3;
        ACT,,ATRIB(1).EQ.3.AND.XX(22).EQ.1,TYP8;
        ACT,,ATRIB(1).EQ.4.AND.NNRSC(F16C).GE.2,TYP2;
        ACT,,ATRIB(1).EQ.4.AND.NNRSC(F16C).LT.2,TYP8;
        ACT,,ATRIB(1).EQ.5.AND.NNRSC(F16C).EQ.0,TYP8;
        ACT,,ATRIB(1).EQ.5.AND.NNRSC(F16C).GE.1,TYP4;
        ACT,,ATRIB(1).EQ.6.AND.NNRSC(F16C).EQ.0,TYP8;
        ACT,,ATRIB(1).EQ.6.AND.NNRSC(F16C).GE.1,TYP4;
        ACT,,ATRIB(1).EQ.7.AND.XX(23).EQ.1,TYP9;
        ACT,,ATRIB(1).EQ.7.AND.XX(23).NE.1.AND.
                                 NNRSC(F16C).LT.2,TYP7;
        ACT,,ATRIB(1).EQ.7.AND.XX(23).NE.1.AND.
                                 NNRSC(F16C).GE.2,TYP6;
        ACT,,ATRIB(1).EQ.8.AND.NNRSC(F16C).LT.2,TYP8;
        ACT,,ATRIB(1).EQ.8.AND.NNRSC(F16C).GE.2,TYP2;
        ACT,,ATRIB(1).EQ.9.AND.NNRSC(F16C).LT.2,TYP8;
```

```
      ACT,,ATRIB(1).EQ.9.AND.NNRSC(F16C).GE.2,TYP2;
      ACT,,ATRIB(1).EQ.10.AND.NNRSC(F16C).LT.2,TYP8;
      ACT,,ATRIB(1).EQ.10.AND.NNRSC(F16C).GE.2,TYP2;
      ACT,,ATRIB(1).EQ.11.AND.NNRSC(F16C).LT.2,TYP8;
      ACT,,ATRIB(1).EQ.11.AND.NNRSC(F16C).GE.2,TYP2;
      ACT,,ATRIB(1).EQ.12.AND.NNRSC(F16C).LT.2,TYP8;
      ACT,,ATRIB(1).EQ.12.AND.NNRSC(F16C).GE.2,TYP2;
      ACT,,ATRIB(1).EQ.13.AND.XX(24).EQ.1,TYP9;
      ACT,,ATRIB(1).EQ.13.AND.XX(24).NE.1.AND.
                              NNRSC(F16C).GE.3,TYP5;
      ACT,,ATRIB(1).EQ.13.AND.XX(24).NE.1.AND.
                              NNRSC(F16C).LT.3,TYP7;
      ACT,,ATRIB(1).EQ.14.AND.XX(25).EQ.1,TYP9;
      ACT,,ATRIB(1).EQ.14.AND.XX(25).NE.1.AND.
                              NNRSC(F16C).GE.3,TYP5;
      ACT,,ATRIB(1).EQ.14.AND.XX(25).NE.1.AND.
                              NNRSC(F16C).LT.3,TYP7;
      ACT,,ATRIB(1).EQ.15.AND.XX(26).EQ.1,TYP8;
      ACT,,ATRIB(1).EQ.15.AND.XX(26).NE.1,TYP3;
      ACT,,ATRIB(1).EQ.16.AND.NNRSC(F16C).LT.2,TYP8;
      ACT,,ATRIB(1).EQ.16.AND.NNRSC(F16C).GE.2,TYP2;
      ACT,,ATRIB(1).EQ.17.AND.XX(27).EQ.1,TYP8;
      ACT,,ATRIB(1).EQ.17.AND.XX(27).NE.1,TYP3;
      ACT,,ATRIB(1).EQ.18.AND.NNRSC(F16C).LT.2,TYP8;
      ACT,,ATRIB(1).EQ.18.AND.NNRSC(F16C).GE.2,TYP2;
      ACT,,ATRIB(1).EQ.19.AND.NNRSC(F16C).LT.2,TYP8;
      ACT,,ATRIB(1).EQ.19.AND.NNRSC(F16C).GE.2,TYP2;
      ACT,,ATRIB(1).EQ.20.AND.XX(28).EQ.1,TYP8;
      ACT,,ATRIB(1).EQ.20.AND.XX(28).NE.1,TYP3;
      ACT,,ATRIB(1).EQ.21.AND.NNRSC(F16C).LT.2,TYP8;
      ACT,,ATRIB(1).EQ.21.AND.NNRSC(F16C).GE.2,TYP2;
;
;     ACADEMIC TRAINING SUBROUTINE
;
ACAD  GOON,1;
      ACT,1/24,XX(8).GE.8,CONT;
;                         IF ACAD HRS/DAY GE 8HRS, DELAY & CONT
      ACT;
      ASSIGN,XX(4)=XX(4)+1; FOR DRAWING ALL SPs
      ACT,,XX(4).EQ.XX(2).OR.NNGAT(DAY).EQ.1,ALSP;
;                         ALL SPs DRAWED & DAY
      ACT;
      AWAIT(7),ACTR;    AWAIT UNTIL ALL SPs GATHERED
      GOON,1;
      ACT,,NNGAT(DAY).EQ.1,NITE;  IF NOT DAY, GO TO NITE
      ACT;
      ASSIGN,XX(4)=XX(4)-1;
;                         FOR CLOSING ACADEMIC TRAINING GATE
      ACT,,XX(4).EQ.0,NASP;
;                         AFTER SPs PASSED, GO TO CLOSING GATE
      ACT;
      GOON,1;
```

```
        ACT,.33/24,NNRSC(IP).EQ.0,CONT;
        ACT;
        GOON,1;
        ACT,,NNRSC(IP).GT.0.AND.XX(5).EQ.1,NOIP;
;                           FOR DRAWING 1 IP
        ACT;
        AWAIT(1),IP;        DRAW 1 IP
        ASSIGN,XX(5)=1;     FOR NOT DRAWING IP
NOIP    GOON;
        ACT,1/24;           ACADEMIC TRAINING 1 HOUR
        GOON,1;
        ACT,,XX(5).EQ.0,NFIP;   FOR NOT RELEASING IP
        ACT;
        ASSIGN,XX(5)=0,XX(8)=XX(8)+1;INCREASE DAILY ACAD HOURS
        FREE,IP;                     RELEASE 1 IP
NFIP    ASSIGN,ATRIB(3)=ATRIB(3)+1;  INCREASE ACADEMIC HOURS
        ACT,,NNGAT(DAY).EQ.1,NASP;   NITE, CLOSE ACAD TRN GATE
        ACT,,,CONT;                  CONTINUE
ALSP    OPEN,ACTR;                   OPEN ACAD TRN GATE
        TERM;
NITE    ASSIGN,XX(4)=0;              RESET SP COUNTER
        ACT,,,CONT;                  RETURN AND CONTINUE
NASP    CLOSE,ACTR;                  CLOSE ACAD TRN GATE
        TERM;
;
;       WX CANCEL SUBROUTINE
;
        CREATE;
WXC     ASSIGN,XX(6)=USERF(2),1;     DRAW WX CANCEL(CNX) RATE
        ACT,,XX(6),CNX;              IF WX BAD
        ACT,,1-XX(6),OPN;            IF WX GOOD
CNX     CLOSE,WX;                    CLOSE WX GATE
;        EVENT,1;
        ASSIGN,XX(13)=0,XX(14)=0,XX(15)=0,XX(20)=0;
        ACT,4/24,,WXC;     EVERY 4 HOUR DRAW WX CNX RATE
OPN     EVENT,1;
        OPEN,WX;           OPEN WX GATE
        ACT,4/24,,WXC;     EVERY 4 HOUR DRAW WX CNX RATE
;
;       DAYLIGHT HOUR SUBROUTINE
;
        CREATE;
NDAY    OPEN,DAY;                    OPEN DAYLIGHT GATE
        CLOSE,ACTR;
        ASSIGN,XX(7)=USERF(3);       DRAW DAYTIME HOURS
        ACT,XX(7);                   DAYTIME
        CLOSE,DAY;                   CLOSE DAYLIGHT GATE
        ASSIGN,XX(8)=0,XX(13)=0,XX(14)=0,
               XX(15)=0,XX(20)=0;    RESET DAILY COUNTER
        EVENT,1;           RELEASE SPs WAITING IPs, ANOTHER SPs
        OPEN,ACTR;         OPEN ACADEMIC TRAINING GATE
        ACT,1-XX(7),,NDAY;           NIGHT
```

```
;
;      COLLECT DAYS COMPLETED
;
COLL   ASSIGN,XX(9)=TNOW-ATRIB(2)+19,
              XX(10)=TNOW-ATRIB(2)-50,
              XX(11)=XX(11)+1;
;                       XX(9): COMPLETE DAYS
;                       XX(10): LATE DAYS
;                       XX(11): COUNTING ALL SPs IN A CLASS
       COLCT,XX(9),COMPLETE DAYS OF SP;
       GOON,1;
       ACT,,XX(11).EQ.XX(2),NOCL; IF ALL SPs COMPLETED
       ACT;                       ELSE
       TERM,43;
;
NOCL   COLCT,XX(9),COMPLETE DAYS OF CLASS;
       ASSIGN,XX(9)=0,XX(10)=0,XX(11)=0,XX(21)=0,XX(22)=0,
              XX(23)=0,XX(24)=0,XX(25)=0,XX(26)=0,XX(27)=0;
       TERM,8;                       ALL CLASSES COMPLETED
;
;
;***** TX MISSION TYPE 1 *****
;    1 SP, 1 IP, 1 F16D
;
TYP1   ASSIGN,ATRIB(5)=1,ATRIB(6)=0;
;                       ASSIGN MSN TYPE, INDEX # OF AREA
       AWAIT(1),IP;                DRAW IP
       ACT,1.5/24;                 PREBRIEFING
       AWAIT(3),F16D;              DRAW  AIRCRAFT
TY1PF  GOON,1;
       ACT,.5/24,XX(31),BR1D;PREFLIGHT CHECK, 1 F-16D FAILURE
       ACT,.5/24,XX(32);           AIRCRAFT NOT FAILURE
       GOON,1;
       ACT,,NNGAT(WX).EQ.1.OR.NNGAT(DAY).EQ.1,WAB1;
;                       BAD WX & NIGHT, ABORT
       ACT,.49/24;
       AWAIT(4),AREA;              DRAW AIRWORK AREA
       ASSIGN,ATRIB(6)=1,1;        INDICATES AREA DRAWED
       ACT,,XX(33),BR1D;           GROUND ABORT
       ACT,1.28/24,XX(34);         FLY MSN
       FREE,AREA;                  RELEASE AREA
       ACT,,,PSC1;                 ACFT POSTFLIGHT CHECK
       ACT,1/24;                   DEBRIEFING
       FREE,IP;                    RELEASE IP
       GOON,1;
       ACT,1/24,XX(80),CONT;  NOT EFFECTIVE MSN, CONTINUE
       ACT;
       GOON,1;                     ASSIGN SORTIE COMPLETED
```

```
      ACT/21,,ATRIB(1).EQ.0,ASN1;
      ACT/22,,ATRIB(1).EQ.1,ASN2;
ASN1  ASSIGN,ATRIB(1)=1,ATRIB(7)=1;
      ACT,1/24,,CONT;             RETURN TO CONTINUEING NODE
ASN2  ASSIGN,ATRIB(1)=2,ATRIB(7)=1;
      ACT,1/24,,CONT;
;
;***** TX MISSION TYPE 2 *****
;      1 SP, 1 IP, 2 F16C
;
TYP2  ASSIGN,ATRIB(5)=2,ATRIB(6)=0;
      AWAIT(1),IP;                      DRAW 1 IP
      ACT,1.5/24;
      AWAIT(2),F16C/2;                  DRAW 2 F16C
TY2PF GOON,1;
      ACT,.5/24,2*XX(31)*XX(32),BR1C;    1 F16C FAILURE
      ACT,.5/24,XX(31)*XX(31),BR2C;      2 F-16Cs FAILURE
      ACT,.5/24,XX(32)*XX(32);           ALL ACFT OK
      GOON,1;
      ACT,,NNGAT(WX).EQ.1.OR.NNGAT(DAY).EQ.1,WAB2;
      ACT,.49/24;
      AWAIT(4),AREA;
      ASSIGN,ATRIB(6)=1,1;
      ACT,,2*XX(33)*XX(34),BR1C;         1 F-16C FAIL
      ACT,,XX(33)*XX(33),BR2C;           2 F-16C FAIL
      ACT,1.28/24,XX(34)*XX(34);         FLY MSN
      FREE,AREA;
      ACT,,,PSC2;
      ACT,1/24;
      FREE,IP;                           RELEASE 1 IP
      GOON,1;
      ACT,1/24,XX(80),CONT;
      ACT;
      GOON,1;
      ACT/23,,ATRIB(1).EQ.4,AS5P;
      ACT/24,,ATRIB(1).EQ.8,AS9P;
      ACT/25,,ATRIB(1).EQ.9,A10P;
      ACT/26,,ATRIB(1).EQ.10,A11P;
      ACT/27,,ATRIB(1).EQ.11,A12P;
      ACT/28,,ATRIB(1).EQ.12,A13P;
      ACT/29,,ATRIB(1).EQ.16,A17P;
      ACT/30,,ATRIB(1).EQ.18,A19P;
      ACT/31,,ATRIB(1).EQ.19,A20P;
      ACT/32,,ATRIB(1).EQ.21,A22P;
AS5P  ASSIGN,ATRIB(1)=5,ATRIB(7)=1;
      ACT,1/24,,CONT;
AS9P  ASSIGN,ATRIB(1)=9,ATRIB(7)=1;
      ACT,1/24,,CONT;
A10P  ASSIGN,ATRIB(1)=10,ATRIB(7)=1;
      ACT,1/24,,CONT;
A11P  ASSIGN,ATRIB(1)=11,ATRIB(7)=1;
      ACT,1/24,,CONT;
```

```
A12P   ASSIGN,ATRIB(1)=12,ATRIB(7)=1;
       ACT,1/24,,CONT;
A13P   ASSIGN,ATRIB(1)=13,ATRIB(7)=1;
       ACT,1/24,,CONT;
A17P   ASSIGN,ATRIB(1)=17,ATRIB(7)=1;
       ACT,1/24,,CONT;
A19P   ASSIGN,ATRIB(1)=19,ATRIB(7)=1;
       ACT,1/24,,CONT;
A2ØP   ASSIGN,ATRIB(1)=2Ø,ATRIB(7)=1;
       ACT,1/24,,CONT;
A22P   ASSIGN,ATRIB(1)=22,ATRIB(7)=1;
       ACT,1/24,,CONT;
;
;***** TX MSN TYPE3 $ UIP MSN TYPE 2 *****
;            2 SP, 2 IP, 2 F16D
;
TYP3   ASSIGN,ATRIB(5)=3,ATRIB(6)=Ø;
GTY3   GOON,1;
       ACT,,XX(13).EQ.Ø,FPLT;
       ACT,,XX(13).EQ.1,SPLT;
FPLT   ASSIGN,XX(13)=1;
       ACT,,,QONE;
SPLT   ASSIGN,XX(13)=Ø;
       ACT,,,QTWO;
QONE   QUEUE(11),,,,MATC;                  WAITING ANOTHER SP
QTWO   QUEUE(12),,,,MATC;                  WAITING ANOTHER SP
MATC   MATCH,1,QONE/MAA,QTWO/MAA;          NEXT MSN SAME
MAA    ACCUM,2,2,LAST;                     DRAW 2 SPs
       AWAIT(1),IP/2;                      DRAW 2 IPs
       ACT,1.5/24;
       AWAIT(3),F16D/2;                    DRAW 2 F-16Ds
TY3PF  GOON,1;
       ACT,.5/24,2*XX(31)*XX(32),BR1D; 1 F-16D FAIL
       ACT,.5/24,XX(31)*XX(31),BR2D;    2 F-16Ds FAIL
       ACT,.5/24,XX(32)*XX(32);
       GOON,1;
       ACT,,NNGAT(WX).EQ.1.OR.NNGAT(DAY).EQ.1,WAB3;
       ACT,.49/24;
       AWAIT(4),AREA;
       ASSIGN,ATRIB(6)=1,1;
       ACT,,2*XX(33)*XX(34),BR1D;         1 F-16D FAIL
       ACT,,XX(33)*XX(33),BR2D;           2 F-16Ds FAIL
       ACT,1.28/24,XX(34)*XX(34);
       FREE,AREA;
       ACT,,,PSC3;
       ACT,1/24;
       FREE,IP/2;                          RELEASE 2 IPs
       ACT;
       ACT;
       GOON,1;
       ACT,,ATRIB(5).EQ.12,GUI2;          RETURN TO UIP MSN
TYPE2
```

```
        ACT;
        GOON,1;
        ACT,1/24,XX(80),CONT;
        ACT;
        GOON,1;
        ACT/33,,ATRIB(1).EQ.2,ASN3;
        ACT/34,,ATRIB(1).EQ.3,ASN4;
        ACT/35,,ATRIB(1).EQ.15,AS16;
        ACT/36,,ATRIB(1).EQ.17,AS18;
        ACT/37,,ATRIB(1).EQ.20,AS21;
ASN3    ASSIGN,ATRIB(1)=3,ATRIB(7)=1;
        ACT,1/24,,CONT;
ASN4    ASSIGN,ATRIB(1)=4,ATRIB(7)=1;
        ACT,1/24,,CONT;
AS16    ASSIGN,ATRIB(1)=16,ATRIB(7)=1;
        ACT,1/24,,CONT;
AS18    ASSIGN,ATRIB(1)=18,ATRIB(7)=1;
        ACT,1/24,,CONT;
AS21    ASSIGN,ATRIB(1)=21,ATRIB(7)=1;
        ACT,1/24,,CONT;
;
;***** TX MISSION TYPE 4 $ UIP MSN TYPE 4 *****
;          1 SP, 2 IP, 1 F16C, 1 F16D
;
TYP4    ASSIGN,ATRIB(5)=4,ATRIB(6)=0;
GTY4    AWAIT(1),IP/2;                    DRAW 2 IPs
        ACT,1.5/24;
        AWAIT(2),F16C;                    DRAW 1 F-16C
        AWAIT(3),F16D;                    DRAW 1 F-16D
TY4PF   GOON,1;
        ACT,0.5/24,XX(31)*XX(32),BRC1; 1 F-16C FAIL
        ACT,0.5/24,XX(31)*XX(32),BRD1; 1 F-16D FAIL
        ACT,0.5/24,XX(31)*XX(31),BC1D1;1 F-16C, 1 F-16D FAIL
        ACT,0.5/24,XX(32)*XX(32);
        GOON,1;
        ACT,,NNGAT(WX).EQ.1.OR.NNGAT(DAY).EQ.1,WAB4;
        ACT,.49/24;
        AWAIT(4),AREA;
        ASSIGN,ATRIB(6)=1,1;
        ACT,,XX(33)*XX(34),BRC1;          1 F-16C FAIL
        ACT,,XX(33)*XX(34),BRD1;          1 F-16D FAIL
        ACT,,XX(33)*XX(33),BC1D1;         1 F-16C, 1 F-16D FAIL
        ACT,1.28/24,XX(34)*XX(34);
        FREE,AREA;
        ACT,,,PSC4;
        ACT,1/24;
        FREE,IP/2;                        RELEASE 2 IPs
        GOON,1;
        ACT,,ATRIB(5).EQ.14,GUI4;         RETURN TO UIP MSN 4
        ACT;
        GOON,1;
        ACT,1/24,XX(80),CONT;
```

```
        ACT;
        GOON,1;
        ACT/38,,ATRIB(1).EQ.5,AS6P;
        ACT/39,,ATRIB(1).EQ.6,AS7P;
AS6P    ASSIGN,ATRIB(1)=6,ATRIB(7)=1;
        ACT,1/24,,CONT;
AS7P    ASSIGN,ATRIB(1)=7,ATRIB(7)=1;
        ACT,1/24,,CONT;
;
;***** TX MISSION TYPE 5 *****
;        1 SP, 2 IP, 3 F16C
;
TYP5    ASSIGN,ATRIB(5)=5,ATRIB(6)=0;
        AWAIT(1),IP/2;                                  DRAW 2 IPs
        ACT,1.5/24;
        AWAIT(2),F16C/3;                                DRAW 3 F-16Cs
TY5PF   GOON,1;
        ACT,0.5/24,3*XX(31)*XX(32)*XX(32),BR1C;  1 F-16C FAIL
        ACT,0.5/24,3*XX(31)*XX(31)*XX(32),BR2C;  2 F-16Cs FAIL
        ACT,0.5/24,XX(31)*XX(31)*XX(31),BR3C;    3 F-16Cs FAIL
        ACT,0.5/24,XX(32)*XX(32)*XX(32);
        GOON,1;
        ACT,,NNGAT(WX).EQ.1.OR.NNGAT(DAY).EQ.1,WAB5;
        ACT,.49/24;
        AWAIT(4),AREA;
        ASSIGN,ATRIB(6)=1,1;
        ACT,,3*XX(33)*XX(34)*XX(34),BR1C;         1 F-16C FAIL
        ACT,,3*XX(33)*XX(33)*XX(34),BR2C;         2 F-16Cs FAIL
        ACT,,XX(33)*XX(33)*XX(33),BR3C;           3 F-16Cs FAIL
        ACT,1.28/24,XX(34)*XX(34)*XX(34);
        FREE,AREA;
        ACT,,,PSC5;
        ACT,1/24;
        FREE,IP/2;                                      RELEASE 2 IPs
        GOON,1;
        ACT,1/24,XX(80),CONT;
        ACT;
        GOON,1;
        ACT/40,,ATRIB(1).EQ.13,A14P;
        ACT/41,,ATRIB(1).EQ.14,A15P;
A14P    ASSIGN,ATRIB(1)=14,ATRIB(7)=1;
        ACT,1/24,,CONT;
A15P    ASSIGN,ATRIB(1)=15,ATRIB(7)=1;
        ACT,1/24,,CONT;
;
;
;***** TX MISSION TYPE 6 & UIP MSN TYPE 3 *****
;            2 SP, 2 IP, 2 F16C, 1 F16D
;
TYP6    ASSIGN,ATRIB(5)=6,ATRIB(6)=0;
GTY6    GOON,1;
        ACT,,XX(14).EQ.0,FTPL;
```

```
      ACT,,XX(14).EQ.1,SDPL;
FTPL  ASSIGN,XX(14)=1;
      ACT,,,QTHRE;
SDPL  ASSIGN,XX(14)=0;
      ACT,,,QFOUR;
QTHRE QUEUE(13),,,,MTCH;
QFOUR QUEUE(14),,,,MTCH;
MTCH  MATCH,1,QTHRE/MAB,QFOUR/MAB;
MAB   ACCUM,2,2,LAST;
      AWAIT(1),IP/2;                           DRAW 2 IPs
      ACT,1.5/24;
      AWAIT(2),F16C/2;                         DRAW 2 F-16Cs
      AWAIT(3),F16D;                           DRAW 1 F-16D
TY6PF GOON,1;
      ACT,.5/24,XX(31)*XX(32)*XX(32),B1D6M;    1 F16D FAIL
      ACT,.5/24,2*XX(31)*XX(32)*XX(32),B1C6M;  1 F16C FAIL
      ACT,.5/24,XX(31)*XX(31)*XX(32),B2C6M;    2 F16C FAIL
      ACT,.5/24,2*XX(31)*XX(31)*XX(32),C1D1B;
;                                       1 F16C, 1 F16D FAIL
      ACT,.5/24,XX(31)*XX(31)*XX(31),B2C1D;
;                                       2 F16C, 1 F16D FAIL
      ACT,.5/24,XX(32)*XX(32)*XX(32);
      GOON,1;
      ACT,,NNGAT(WX).EQ.1.OR.NNGAT(DAY).EQ.1,WAB6;
      ACT,.49/24;
      AWAIT(4),AREA;
      ASSIGN,ATRIB(6)=1,1;
      ACT,,XX(33)*XX(34)*XX(34),B1D6M;         1 F16D FAIL
      ACT,,2*XX(33)*XX(34)*XX(34),B1C6M;       1 F16C FAIL
      ACT,,XX(33)*XX(33)*XX(34),B2C6M;         2 F16C FAIL
      ACT,,2*XX(33)*XX(33)*XX(34),C1D1B; 1 F16C, 1 F16D FAIL
      ACT,,XX(33)*XX(33)*XX(33),B2C1D;   2 F16C, 1 F16D FAIL
      ACT,1.28/24,XX(34)*XX(34)*XX(34);
      FREE,AREA;
      ACT,,,PSC6;
      ACT,1/24;
      FREE,IP/2;
      ACT;
      ACT;
      GOON,1;
      ACT,,ATRIB(5).EQ.13,GUI3;     RETURN TO UIP MSN TYPE 3
      ACT;
      GOON,1;
      ACT,1/24,XX(80),CONT;
      ACT;
      ASSIGN,ATRIB(1)=8,ATRIB(7)=1;
      ACT/42,1/24,,CONT;
;
;***** TX MSN TYPE 7 *****
;   2 SP, 2 IP, 3 F16D
;
TYP7  ASSIGN,ATRIB(5)=7,ATRIB(6)=0,1;
```

```
       ACT,,XX(15).EQ.Ø,FRTP;
       ACT,,XX(15).EQ.1,SCDP;
FRTP   ASSIGN,XX(15)=1;
       ACT,,,QFIVE;
SCDP   ASSIGN,XX(15)=Ø;
       ACT,,,QSIX;
QFIVE  QUEUE(15),,,,MACH;
QSIX   QUEUE(16),,,,MACH;
MACH   MATCH,1,QFIVE/MAC,QSIX/MAC;
MAC    ACCUM,2,2,LAST;
       AWAIT(1),IP/2;                                DRAW 2 IPs
       ACT,1.5/24;
       AWAIT(3),F16D/3;                              DRAW 3 F-16Ds
TY7PF  GOON,1;
       ACT,.5/24,3*XX(31)*XX(32)*XX(32),B1D7M;  1 F16D FAIL
       ACT,.5/24,3*XX(31)*XX(31)*XX(32),B2D7M;  2 F16D FAIL
       ACT,.5/24,XX(31)*XX(31)*XX(31),B3D7M;    3 F16D FAIL
       ACT,.5/24,XX(32)*XX(32)*XX(32);
       GOON,1;
       ACT,,NNGAT(WX).EQ.1.OR.NNGAT(DAY).EQ.1,WAB7;
       ACT,.49/24;
       AWAIT(4),AREA;
       ASSIGN,ATRIB(6)=1,1;
       ACT,,3*XX(33)*XX(34)*XX(34),B1D7M;       1 F16D FAIL
       ACT,,3*XX(33)*XX(33)*XX(34),B2D7M;       2 F16D FAIL
       ACT,,XX(33)*XX(33)*XX(33),B3D7M;         3 F16D FAIL
       ACT,1.28/24,XX(34)*XX(34)*XX(34);
       FREE,AREA;
       ACT,,,PSC7;
       ACT,1/24;
       FREE,IP/2;
       ACT;
       ACT;
       GOON,1;
       ACT,1/24,XX(8Ø),CONT;
       ACT;
       GOON,1;
       ACT/43,,ATRIB(1).EQ.7,AS8S;
       ACT/44,,ATRIB(1).EQ.13,A14S;
       ACT/45,,ATRIB(1).EQ.14,A15S;
AS8S   ASSIGN,ATRIB(1)=8,ATRIB(7)=1;
       ACT,1/24,,CONT;
A14S   ASSIGN,ATRIB(1)=14,ATRIB(7)=1;
       ACT,1/24,,CONT;
A15S   ASSIGN,ATRIB(1)=15,ATRIB(7)=1;
       ACT,1/24,,CONT;
;
;***** TX MISSION TYPE 8 & UIP MSN TYPE 5 *****
;              1 SP, 2 IP, 2 F16D
;
TYP8   ASSIGN,ATRIB(5)=8,ATRIB(6)=Ø;
GTY8   AWAIT(1),IP/2;                        DRAW 2 IPs
```

```
       ACT,1.5/24;
       AWAIT(3),F16D/2;                       DRAW 2 F-16Ds
TY8PF  GOON,1;
       ACT,.5/24,2*XX(31)*XX(32),BR1D;        1 F-16D FAIL
       ACT,.5/24,XX(31)*XX(31),BR2D;          2 F-16Ds FAIL
       ACT,.5/24,XX(32)*XX(32);
       GOON,1;
       ACT,,NNGAT(WX).EQ.1.OR.NNGAT(DAY).EQ.1,WAB8;
       ACT,.49/24;
       AWAIT(4),AREA;
       ASSIGN,ATRIB(6)=1,1;
       ACT,,2*XX(33)*XX(34),BR1D;
       ACT,,XX(33)*XX(33),BR2D;
       ACT,1.28/24,XX(34)*XX(34);
       FREE,AREA;
       ACT,,,PSC3;
       ACT,1/24;
       FREE,IP/2;
       GOON,1;
       ACT,,ATRIB(5).EQ.15,GUI5;     RETURN TO UIP MSN TYPE 5
       ACT;
       GOON,1;
       ACT,1/24,XX(80),CONT;
       ACT;
       GOON,1;
       ACT/46,,ATRIB(1).EQ.2,AS3A;
       ACT/47,,ATRIB(1).EQ.3,AS4A;
       ACT/48,,ATRIB(1).EQ.4,AS5A;
       ACT/49,,ATRIB(1).EQ.5,AS6A;
       ACT/50,,ATRIB(1).EQ.6,AS7A;
       ACT/51,,ATRIB(1).EQ.8,AS9A;
       ACT/52,,ATRIB(1).EQ.9,A10A;
       ACT/53,,ATRIB(1).EQ.10,A11A;
       ACT/54,,ATRIB(1).EQ.11,A12A;
       ACT/55,,ATRIB(1).EQ.12,A13A;
       ACT/56,,ATRIB(1).EQ.15,A16A;
       ACT/57,,ATRIB(1).EQ.16,A17A;
       ACT/58,,ATRIB(1).EQ.17,A18A;
       ACT/59,,ATRIB(1).EQ.18,A19A;
       ACT/60,,ATRIB(1).EQ.19,A20A;
       ACT/61,,ATRIB(1).EQ.20,A21A;
       ACT/62,,ATRIB(1).EQ.21,A22A;
AS3A   ASSIGN,ATRIB(1)=3,ATRIB(7)=1;
       ACT,1/24,,CONT;
AS4A   ASSIGN,ATRIB(1)=4,ATRIB(7)=1;
       ACT,1/24,,CONT;
AS5A   ASSIGN,ATRIB(1)=5,ATRIB(7)=1;
       ACT,1/24,,CONT;
AS6A   ASSIGN,ATRIB(1)=6,ATRIB(7)=1;
       ACT,1/24,,CONT;
AS7A   ASSIGN,ATRIB(1)=7,ATRIB(7)=1;
       ACT,1/24,,CONT;
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AS9A   ASSIGN,ATRIB(1)=9,ATRIB(7)=1;
       ACT,1/24,,CONT;
A10A   ASSIGN,ATRIB(1)=10,ATRIB(7)=1;
       ACT,1/24,,CONT;
A11A   ASSIGN,ATRIB(1)=11,ATRIB(7)=1;
       ACT,1/24,,CONT;
A12A   ASSIGN,ATRIB(1)=12,ATRIB(7)=1;
       ACT,1/24,,CONT;
A13A   ASSIGN,ATRIB(1)=13,ATRIB(7)=1;
       ACT,1/24,,CONT;
A16A   ASSIGN,ATRIB(1)=16,ATRIB(7)=1;
       ACT,1/24,,CONT;
A17A   ASSIGN,ATRIB(1)=17,ATRIB(7)=1;
       ACT,1/24,,CONT;
A18A   ASSIGN,ATRIB(1)=18,ATRIB(7)=1;
       ACT,1/24,,CONT;
A19A   ASSIGN,ATRIB(1)=19,ATRIB(7)=1;
       ACT,1/24,,CONT;
A20A   ASSIGN,ATRIB(1)=20,ATRIB(7)=1;
       ACT,1/24,,CONT;
A21A   ASSIGN,ATRIB(1)=21,ATRIB(7)=1;
       ACT,1/24,,CONT;
A22A   ASSIGN,ATRIB(1)=22,ATRIB(7)=1;
       ACT,1/24,,CONT;
;
;
;***** TX MISSION TYPE 9 *****
;       1 SP, 2 IP, 3 F16D
;
TYP9   ASSIGN,ATRIB(5)=9,ATRIB(6)=0;
       AWAIT(1),IP/2;                                DRAW 2 IPs
       ACT,1.5/24;
       AWAIT(3),F16D/3;                              DRAW 3 F-16Ds
TY9PF  GOON,1;
       ACT,.5/24,3*XX(31)*XX(32)*XX(32),B1D7M;  1 F16D FAIL
       ACT,.5/24,3*XX(31)*XX(31)*XX(32),B2D7M;  2 F16D FAIL
       ACT,.5/24,XX(31)*XX(31)*XX(31),B3D7M;    3 F16D FAIL
       ACT,.5/24,XX(32)*XX(32)*XX(32);
       GOON,1;
       ACT,,NNGAT(WX).EQ.1.OR.NNGAT(DAY).EQ.1,WAB9;
       ACT,.49/24;
       AWAIT(4),AREA;
       ASSIGN,ATRIB(6)=1,1;
       ACT,,3*XX(33)*XX(34)*XX(34),B1D7M;       1 F16D FAIL
       ACT,,3*XX(33)*XX(33)*XX(34),B2D7M;       2 F16D FAIL
       ACT,,XX(33)*XX(33)*XX(33),B3D7M;         3 F16D FAIL
       ACT,1.28/24,XX(34)*XX(34)*XX(34);
       FREE,AREA;
       ACT,,,PSC7;
       ACT,1/24;
       FREE,IP/2;
       GOON,1;
```

```
        ACT,1/24,XX(60),CONT;
        ACT;
        GOON,1;
        ACT/63,,ATRIB(1).EQ.7,AS8A;
        ACT/64,,ATRIB(1).EQ.13,A14A;
        ACT/65,,ATRIB(1).EQ.14,A15A;
AS8A    ASSIGN,ATRIB(1)=8,ATRIB(7)=1;
        ACT,1/24,,CONT;
A14A    ASSIGN,ATRIB(1)=14,ATRIB(7)=1;
        ACT,1/24,,CONT;
A15A    ASSIGN,ATRIB(1)=15,ATRIB(7)=1;
        ACT,1/24,,CONT;
;
;*****  ACFT POST-FLIGHT CHECK  *****
;
PSC1    QUEUE(21);
        ACT,.5/24,XX(35),RP1D;                         1 F-16D FAILURE
        ACT,.5/24,XX(36);                              ACFT OK
        FREE,F16D;                                     RELEASE ACFT
        TERM;
;
PSC2    QUEUE(22);
        ACT(2),.5/24,2*XX(35)*XX(36),RL1C2;             1 F16C FAILURE
        ACT(2),.5/24,XX(35)*XX(35),RP2C;                2 F16C FAILURE
        ACT(2),.5/24,XX(36)*XX(36);                     ACFT OK
        FREE,F16C/2;
        TERM;
;
PSC3    QUEUE(23);
        ACT(2),.5/24,2*XX(35)*XX(36),RL1D1;
        ACT(2),.5/24,XX(35)*XX(35),RP2D;
        ACT(2),.5/24,XX(36)*XX(36);
        FREE,F16D/2;
        TERM;
;
PSC4    QUEUE(24);
        ACT(2),0.5/24,XX(35)*XX(36),R1FC;               1 F16D FAIL
        ACT(2),0.5/24,XX(35)*XX(36),R1FD;               1 F16C FAIL
        ACT(2),0.5/24,XX(35)*XX(35),RC1D1;              1 F16C, 1 F16D
FAIL
        ACT(2),0.5/24,XX(36)*XX(36);                    NO ACFT FAIL
        FREE,F16C;
        FREE,F16D;
        TERM;
;
PSC5    QUEUE(25);
        ACT(3),0.5/24,3*XX(35)*XX(36)*XX(36),RL1C2;
        ACT(3),0.5/24,3*XX(35)*XX(35)*XX(36),RL2C2;
        ACT(3),0.5/24,XX(35)*XX(35)*XX(35),RP3C;
        ACT(3),0.5/24,XX(36)*XX(36)*XX(36);
        FREE,F16C/3;
```

```
      TERM;
;
PSC6  QUEUE(26);
      ACT(3),.5/24,XX(35)*XX(36)*XX(36),F2C6M;    1 F16D FAIL
      ACT(3),.5/24,2*XX(35)*XX(36)*XX(36),F1C1D; 1 F16C FAIL
      ACT(3),.5/24,XX(35)*XX(35)*XX(36),F1D6M;    2 F16C FAIL
      ACT(3),.5/24,2*XX(35)*XX(35)*XX(36),F1C6M;
;                                           1 F16C, 1 F16D FAIL
      ACT(3),.5/24,XX(35)*XX(35)*XX(35),F2C1D;
;                                           2 F16C, 1 F16D FAIL
      ACT(3),.5/24,XX(36)*XX(36)*XX(36); NO ACFT FAIL
      FREE,F16C/2;
      FREE,F16D;
      TERM;
;
PSC7  QUEUE(27);
      ACT(3),.5/24,3*XX(35)*XX(36)*XX(36),F2D7M;
      ACT(3),.5/24,3*XX(35)*XX(35)*XX(36),F1D7M;
      ACT(3),.5/24,XX(35)*XX(35)*XX(35),RP3D;
      ACT(3),.5/24,XX(36)*XX(36)*XX(36);
      FREE,F16D/3;
      TERM;
;
;*****  WX BAD OR NIGHT BEFORE STARTING ENGINE  *****
;
WAB1  FREE,F16D;                     RELEASE  F16D
      FREE,IP;                       RELEASE  IP
      ACT,,,CONT;                    RETURN TO COMTINUING NODE
;
WAB2  FREE,F16C/2;
      FREE,IP;
      ACT,,,CONT;
;
WAB3  FREE,F16D/2;
      FREE,IP/2;
      GOON,1;
      ACT,,ATRIB(5).EQ.12,GUC1;  RETURN TO UIP TRAINING
      ACT;
      GOON;
      ACT,,,CONT;
      ACT,,,CONT;
GUC1  GOON;                          RETURN 2 UIP
      ACT,,,UCONT;
      ACT,,,UCONT;
;
WAB4  FREE,F16C;
      FREE,F16D;
      FREE,IP/2;
      GOON,1;
      ACT,,ATRIB(5).EQ.4,CONT;
      ACT,,ATRIB(5).EQ.14,UCONT; RETURN 1 UIP TO UIP TRN
;
```

```
WAB5   FREE,F16C/3;
       FREE,IP/2;
       ACT,,,CONT;
;
WAB6   FREE,F16C/2;
       FREE,F16D;
       FREE,IP/2;
       GOON,1;
       ACT,,ATRIB(5).EQ.13,GUC1;  RETURN TO UIP TRAINING
       ACT;
       GOON;
       ACT,,,CONT;
       ACT,,,CONT;
;
WAB7   FREE,F16D/3;
       FREE,IP/2;
       ACT,,,CONT;
       ACT,,,CONT;
;
WAB8   FREE,F16D/2;
       FREE,IP/2;
       GOON,1;
       ACT,,ATRIB(5).EQ.8,CONT;
       ACT,,ATRIB(5).EQ.15,UCONT; RETURN TO UIP TRAINING
;
WAB9   FREE,IP/2;
       FREE,F16D/3;
       ACT,,,CONT;
;
WA11   FREE,IP;
       FREE,F16D;
       FREE,F16C;
       ACT,,,UCONT;
       ACT,,,UCONT;
;
;***** AIRCRAFT  FAILURE SUBROUTINES *****
;
;  1 F-16D FAILURE FROM MSN TYPE 1, 3, 8
;
BR1D   ASSIGN,ATRIB(4)=1;
       ACT,,,FRAR;
NFA1   GOON,2;
       ACT,,,RL1D1;                   REPAIR ACFT
       ACT,,NNRSC(F16D).GE.1,SP1D;    SPARE ACFT AVAILABLE?
       ACT;
       GOON,1;
       ACT,,ATRIB(5).EQ.1,F1I1S;      IF 1 IP DRAWED
       ACT,,ATRIB(5).EQ.8,F2I1S;
       ACT,,ATRIB(5).EQ.12,F2U2I;
       ACT,,ATRIB(5).EQ.15,F1U2I;
       ACT,,,F2I2S;
F1I1S  FREE,IP;
```

```
        ACT,3/24,,CONT;
F2I2S FREE,IP/2;                          RELEASE 2 IP
        ACT,3/24,,CONT;
        ACT,3/24,,CONT;
F2I1S FREE,IP/2;
        ACT,3/24,,CONT;
F2U2I FREE,IP/2;
        ACT,3/24,,UCONT;                  RETURN TO UIP TRAINING
(2 UIP)
        ACT,3/24,,UCONT;
F1U2I FREE,IP/2;
        ACT,3/24,,UCONT;      RETURN TO UIP TRAINING (1 UIP)
;
SP1D    GOON,1;
        ACT,,ATRIB(5).EQ.1,DR1D;          IF 1 F16D NEEDED
        ACT;                               " 2   "    "
        AWAIT(3),F16D;                    DRAW 1 F16D
DR1D    AWAIT(3),F16D;                    DRAW 1 MORE F16D
        GOON,1;                           AFTER DRAWING SPARE ACFT
        ACT,,ATRIB(5).EQ.1,TY1PF;   GO TO PREFLIGHT CHECK
        ACT,,ATRIB(5).EQ.3.OR.ATRIB(5).EQ.12,TY3PF;
        ACT,,ATRIB(5).EQ.8.OR.ATRIB(5).EQ.15,TY8PF;
;
RL1D1 GOON,1;
        ACT,,ATRIB(5).EQ.1,RP1D;
        ACT;
        FREE,F16D;
        ACT,,,RP1D;
;
;       2 F16D FAIL FROM MSN TYPE 3, 8
;
BR2D    ASSIGN,ATRIB(4)=2;
        ACT,,,FRAR;
NFA2    GOON,2;
        ACT,,,RP2D;
        ACT,,NNRSC(F16D).GE.2,SP2D;
        ACT;
        FREE,IP/2;
        GOON,1;
        ACT,,ATRIB(5).EQ.8,F1SP;
        ACT,,ATRIB(5).EQ.12,F2UIP;
        ACT,,ATRIB(5).EQ.15,F1UIP;
        ACT;
        GOON;
        ACT,3/24,,CONT;
        ACT,3/24,,CONT;
F1SP    GOON;
        ACT,3/24,,CONT;
F1UIP GOON;
        ACT,3/24,,UCONT;      RETURN TO UIP TRAINING (1 UIP)
F2UIP GOON;
        ACT,3/24,,UCONT;      RETURN TO UIP TRAINING (2 UIP)
```

```
      ACT,3/24,,UCONT;
;
;     DRAW SPARE ACFT 2 F16D
;
SP2D  AWAIT(3),F16D/2;
      GOON,1;
      ACT,,ATRIB(5).EQ.3.OR.ATRIB(5).EQ.12,TY3PF;
      ACT,,ATRIB(5).EQ.8.OR.ATRIB(5).EQ.15,TY8PF;
;
;     1 F16C FAIL FROM MSN TYPE 2, 5
;
BR1C  ASSIGN,ATRIB(4)=3;
      ACT,,,FRAR;
NFA3  GOON,2;
      ACT,,,RL1C2;
      ACT,,NNRSC(F16C).GE.1,SP1C;
      ACT,,,FRIP;
FRIP  GOON,1;
      ACT,,ATRIB(5).NE.5,F1IP;
      ACT;
      FREE,IP;
F1IP  FREE,IP;
      ACT,3/24,,CONT;
;
;     DRAW SPARE ACFT 1 F16C
;
SP1C  GOON,1;
      ACT,,ATRIB(5).NE.5,DS2C;
      ACT;
      AWAIT(2),F16C;
DS2C  AWAIT(2),F16C/2;
      GOON,1;
      ACT,,ATRIB(5).EQ.2,TY2PF;
      ACT,,ATRIB(5).EQ.5,TY5PF;
RL1C2 GOON,1;
      ACT,,ATRIB(5).NE.5,R1C5M;
      ACT;
      FREE,F16C;
R1C5M FREE,F16C;
      ACT,,,RP1C;
;
;     2 F16C FAIL FROM MSN TYPE 2, 5
;
BR2C  ASSIGN,ATRIB(4)=4;
      ACT,,,FRAR;
NFA4  GOON,2;
      ACT,,,RL2C2;
      ACT,,NNRSC(F16C).GE.2,SP2C;
      ACT,,,FRIP;
;
;     DRAW SPARE ACFT 2 F16C
;
```

```
SP2C  GOON,1;
      ACT,,ATRIB(5).NE.5,DS1C;
      ACT;
      AWAIT(2),F16C;
DS1C  AWAIT(2),F16C/2;
      GOON,1;
      ACT,,ATRIB(5).EQ.2,TY2PF;
      ACT,,ATRIB(5).EQ.5,TY5PF;
RL2C2 GOON,1;
      ACT,,ATRIB(5).NE.5,RP2C;
      ACT;
      FREE,F16C;
      ACT,,,RP2C;
;
;     3 F16C FAIL
;
BR3C  ASSIGN,ATRIB(4)=5;
      ACT,,,FRAR;
NFA5  GOON,2;
      ACT,,,RP3C;
      ACT,,NNRSC(F16C).GE.3,SP3C;
      ACT;
      FREE,IP/2;
      ACT,3/24,,CONT;
SP3C  AWAIT(2),F16C/3;
      ACT,,,TY5PF;
;
; ***** ACFT FAILURE FROM TX MSN TYPE 4 *****
; *****       UIP MSN TYPE 1, 4         *****
;
BRC1  ASSIGN,ATRIB(4)=6;
      ACT,,,FRAR;
NFA6  GOON,2;
      ACT,,,R1FC;
      ACT,,NNRSC(F16C).GE.1,DST5;
      ACT,,,DLC5;
DLC5  GOON,1;
      ACT,,ATRIB(5).EQ.11,R1IP;
      ACT;
      FREE,IP;
R1IP  FREE,IP;
      GOON,1;
      ACT,3/24,ATRIB(5).EQ.4,CONT;
      ACT,3/24,ATRIB(5).EQ.11,GUCO;  RETURN 2 UIP TO UIP TRN
      ACT,3/24,ATRIB(5).EQ.14,UCONT;
;
DST5  AWAIT(2),F16C;
      AWAIT(3),F16D;
      GOON,1;
      ACT,,ATRIB(5).EQ.11,UI1PF;
      ACT,,,TY4PF;
;
```

```
R1FC  FREE,F16D;
      ACT,,,RP1C;
;
;
BRD1  ASSIGN,ATRIB(4)=7;
      ACT,,,FRAR;
NFA7  GOON,2;
      ACT,,,R1FD;
      ACT,,NNRSC(F16D).GE.1,DST5;
      ACT,,,DLC5;
;
R1FD  FREE,F16C;
      ACT,,,RP1D;
;
;
BC1D1 ASSIGN,ATRIB(4)=8;
      ACT,,,FRAR;
NFA8  GOON,2;
      ACT,,,RC1D1;
      ACT,,NNRSC(F16C).GE.1.AND.NNRSC(F16D).GE.1,DST5;
      ACT,,,DLC5;
RC1D1 GOON;
      ACT,,,RP1C;
      ACT,,,RP1D;
;
; ***** ACFT FAILURE FROM MSN TYPE 6 *****
;
B1D6M ASSIGN,ATRIB(4)=9;
      ACT,,,FRAR;
NFA9  GOON,2;
      ACT,,,F2C6M;                    RELEASE ACFT & REPAIR
      ACT,,NNRSC(F16D).GE.1,DST6;     DRAW SPARE ACFT
      ACT,,,DLC6;                     DELAY & CONTINUE
F2C6M FREE,F16C/2;
      ACT,,,RP1D;
DST6  AWAIT(2),F16C/2;
      AWAIT(3),F16D;
      ACT,,,TY6PF;
;
DLC6  FREE,IP/2;
      GOON,1;
      ACT,,ATRIB(5).EQ.13,GUCO;
      ACT;
      GOON;
      ACT,3/24,,CONT;
      ACT,3/24,,CONT;
GUCO  GOON;
      ACT,3/24,,UCONT;
      ACT,3/24,,UCONT;
;
B1C6M ASSIGN,ATRIB(4)=10;
      ACT,,,FRAR;
```

```
NA10  GOON,2;
      ACT,,,F1C1D;
      ACT,,NNRSC(F16C).GE.1,DST6;
      ACT,,,DLC6;
F1C1D FREE,F16C;
      FREE,F16D;
      ACT,,,RP1C;
;
B2C6M ASSIGN,ATRIB(4)=11;
      ACT,,,FRAR;
NA11  GOON,2;
      ACT,,,F1D6M;
      ACT,,NNRSC(F16C).GE.2,DST6;
      ACT,,,DLC6;
F1D6M FREE,F16D;
      ACT,,,RP2C;
;
C1D1B ASSIGN,ATRIB(4)=12;
      ACT,,,FRAR;
NA12  GOON,2;
      ACT,,,F1C6M;
      ACT,,NNRSC(F16C).GE.1.AND.NNRSC(F16D).GE.1,DST6;
      ACT,,,DLC6;
F1C6M FREE,F16C;
      ACT,,,RP1D;
      ACT,,,RP1C;
;
B2C1D ASSIGN,ATRIB(4)=13;
      ACT,,,FRAR;
NA13  GOON,2;
      ACT,,,F2C1D;
      ACT,,NNRSC(F16C).GE.2.AND.NNRSC(F16D).GE.1,DST6;
      ACT,,,DLC6;
F2C1D GOON;
      ACT,,,RP2C;
      ACT,,,RP1D;
;
; ***** ACFT FAILURE IN MSN TYPE 7, 9 *****
;
B1D7M ASSIGN,ATRIB(4)=14;
      ACT,,,FRAR;
NA14  GOON,2;
      ACT,,,F2D7M;
      ACT,,NNRSC(F16D).GE.1,DST7;
      ACT,,,DLC7;
F2D7M FREE,F16D/2;
      ACT,,,RP1D;
;
DST7  AWAIT(3),F16D/3;
      GOON,1;
      ACT,,ATRIB(5).EQ.7,TY7PF;
      ACT,,ATRIB(5).EQ.9,TY9PF;
```

```
DLC7  FREE,IP/2;
      GOON,1;
      ACT,,ATRIB(5).EQ.9,R1SP;
      ACT;
      GOON;
      ACT,3/24,,CONT;
      ACT,3/24,,CONT;
R1SP  GOON;
      ACT,3/24,,CONT;
;
B2D7M ASSIGN,ATRIB(4)=15;
      ACT,,,FRAR;
NA15  GOON,2;
      ACT,,,F1D7M;
      ACT,,NNRSC(F16D).GE.2,DST7;
      ACT,,,DLC7;
F1D7M FREE,F16D;
      ACT,,,RP2D;
;
B3D7M ASSIGN,ATRIB(4)=16;
      ACT,,,FRAR;
NA16  GOON,2;
      ACT,,,RP3D;
      ACT,,NNRSC(F16D).GE.3,DST7;
      ACT,,,DLC7;
;
FRAR  GOON,1;
      ACT,,ATRIB(6).EQ.Ø,NFAR;
      ACT;
      FREE,AREA;
NFAR  ASSIGN,ATRIB(6)=Ø,1;
      ACT,,ATRIB(4).EQ.1,NFA1;
      ACT,,ATRIB(4).EQ.2,NFA2;
      ACT,,ATRIB(4).EQ.3,NFA3;
      ACT,,ATRIB(4).EQ.4,NFA4;
      ACT,,ATRIB(4).EQ.5,NFA5;
      ACT,,ATRIB(4).EQ.6,NFA6;
      ACT,,ATRIB(4).EQ.7,NFA7;
      ACT,,ATRIB(4).EQ.8,NFA8;
      ACT,,ATRIB(4).EQ.9,NFA9;
      ACT,,ATRIB(4).EQ.1Ø,NA1Ø;
      ACT,,ATRIB(4).EQ.11,NA11;
      ACT,,ATRIB(4).EQ.12,NA12;
      ACT,,ATRIB(4).EQ.13,NA13;
      ACT,,ATRIB(4).EQ.14,NA14;
      ACT,,ATRIB(4).EQ.15,NA15;
      ACT,,ATRIB(4).EQ.16,NA16;
;
;*****  AIRCRAFT REPAIR SUBROUTINES  *****
;
;     1 F-16D REPAIR
RP1D  QUEUE(3Ø);
```

```
        ACT,1,.3,R1D;                        MAJOR FAIL
        ACT,Ø.5/24,.7;                       MINOR FAIL
R1D     FREE,F16D;                           RELEASE 1 F16D
        TERM;
;
;       2 F-16D REPAIR
RP2D    QUEUE(31);
        ACT,1,.3,R2D;
        ACT,Ø.5/24,.7;
R2D     FREE,F16D/2;
        TERM;
;
;       3 F-16D REPAIR
RP3D    QUEUE(32);
        ACT,1,.3,R3D;
        ACT,Ø.5/24,.7;
R3D     FREE,F16D/3;
        TERM;
;
;       1 F-16C REPAIR
RP1C    QUEUE(33);
        ACT,1,.3,R1C;
        ACT,Ø.5/24,.7;
R1C     FREE,F16C;
        TERM;
;
;       2 F-16C REPAIR
RP2C    QUEUE(34);
        ACT,1,.3,R2C;
        ACT,Ø.5/24,.7;
R2C     FREE,F16C/2;
        TERM;
;
;       3 F-16C REPAIR
;
RP3C    QUEUE(35);
        ACT,1,Ø.3,R3C;
        ACT,Ø.5/24,Ø.7;
R3C     FREE,F16C/3
        TERM;
;
;
;*****  UPGRADING INSTRUCTOR PILOT TRAINING  *****
;
;
UALT    ASSIGN,XX(16)=XX(16)+1;
        ALTER,IP/-1;
        ACT,5;
        ALTER,IP/1;
        TERM;
;
UIPT    GOON;
```

```
     ACT,7;              PRE-FLIGHT ACADEMICS
     ASSIGN,ATRIB(1)=0,ATRIB(2)=TNOW,ATRIB(3)=40,
            ATRIB(7)=0,ATRIB(8)=XX(16),ATRIB(9)=2;
UCONT GOON,1;
     ACT,,ATRIB(1).GE.16.AND.ATRIB(3).GE.40,UCOL;
;                   IF COMPLETE FLY' & ACAD
     ACT;           NOT COMPLETE FLY' & ACDADEMICS, CONTINUE
     GOON,1;
     ACT,,NNGAT(DAY).EQ.0,SFPD;
     ACT;
     ASSIGN,ATRIB(7)=0;
SFPD  AWAIT(8),DAY,1;   WAITING DAYLIGHT HOURS
     ACT,,NNGAT(WX).EQ.0.AND.NNRSC(IP).GE.1.AND.
          NNRSC(F16D).GE.1.AND.NNRSC(AREA).GE.1.AND.
          ATRIB(7).EQ.0,UFLY;
;                   IF IP,ACFT,AREA AVAIL' & NOT COMPLETED
     ACT,1/24,,UCONT; ELSE, DELAY 1 HRS & CONTINUE.
;
;
UFLY  ASSIGN,XX(61)=XX(3)*ATRIB(8)-NNCNT(73)-NNCNT(89),
            XX(62)=XX(3)*ATRIB(8)-NNCNT(74)-NNCNT(90),
            XX(63)=XX(3)*ATRIB(8)-NNCNT(66)-NNCNT(82),
            XX(64)=XX(3)*ATRIB(8)-NNCNT(67)-NNCNT(83);
     ASSIGN,XX(65)=XX(3)*ATRIB(8)-NNCNT(68)-NNCNT(84),
            XX(66)=XX(3)*ATRIB(8)-NNCNT(69)-NNCNT(85),
            XX(67)=XX(3)*ATRIB(8)-NNCNT(79)-NNCNT(91),
            XX(68)=XX(3)*ATRIB(8)-NNCNT(80)-NNCNT(92);
     ASSIGN,XX(69)=XX(3)*ATRIB(8)-NNCNT(81)-NNCNT(93),
            XX(70)=XX(3)*ATRIB(8)-NNCNT(70)-NNCNT(86),
            XX(71)=XX(3)*ATRIB(8)-NNCNT(71)-NNCNT(87),
            XX(72)=XX(3)*ATRIB(8)-NNCNT(75)-NNCNT(94);
     ASSIGN,XX(73)=XX(3)*ATRIB(8)-NNCNT(76)-NNCNT(95),
            XX(74)=XX(3)*ATRIB(8)-NNCNT(72)-NNCNT(88),
            XX(75)=XX(3)*ATRIB(8)-NNCNT(77)-NNCNT(96),
            XX(76)=XX(3)*ATRIB(8)-NNCNT(78)-NNCNT(97),1;
;
;    DETERMINE MISSION TYPE ACCORDING TO # OF SP, # OF IP,
;    # AND TYPE OF AAIRCRAFT
;
     ACT,,ATRIB(1).EQ.0.AND.XX(61).EQ.1,UIP5;
     ACT,,ATRIB(1).EQ.0,UIP2;
     ACT,,ATRIB(1).EQ.1.AND.XX(62).EQ.1,UIP5;
     ACT,,ATRIB(1).EQ.1,UIP2;
     ACT,,ATRIB(1).EQ.2.AND.XX(63).EQ.1,UIP4;
     ACT,,ATRIB(1).EQ.2,UIP1;
     ACT,,ATRIB(1).EQ.3.AND.XX(64).EQ.1,UIP4
     ACT,,ATRIB(1).EQ.3,UIP1;
     ACT,,ATRIB(1).EQ.4.AND.XX(65).EQ.1,UIP4;
     ACT,,ATRIB(1).EQ.4,UIP1;
     ACT,,ATRIB(1).EQ.5.AND.XX(66).EQ.1,UIP4;
     ACT,,ATRIB(1).EQ.5,UIP1;
     ACT,,ATRIB(1).EQ.6.AND.XX(67).NE.1.AND.
```

```
                                 NNRSC(F16C).GE.2,UIP3;
        ACT,,ATRIB(1).EQ.6,UIP5;
        ACT,,ATRIB(1).EQ.7.AND.XX(68).NE.1.AND.
                                 NNRSC(F16C).GE.2,UIP3;
        ACT,,ATRIB(1).EQ.7,UIP5;
        ACT,,ATRIB(1).EQ.8.AND.XX(69).NE.1.AND.
                                 NNRSC(F16C).GE.2,UIP3;
        ACT,,ATRIB(1).EQ.8,UIP5;
        ACT,,ATRIB(1).EQ.9.AND.XX(70).EQ.1,UIP4;
        ACT,,ATRIB(1).EQ.9,UIP1;
        ACT,,ATRIB(1).EQ.10.AND.XX(71).EQ.1,UIP4;
        ACT,,ATRIB(1).EQ.10,UIP1;
        ACT,,ATRIB(1).EQ.11.AND.XX(72).EQ.1,UIP5;
        ACT,,ATRIB(1).EQ.11,UIP2;
        ACT,,ATRIB(1).EQ.12.AND.XX(73).EQ.1,UIP5;
        ACT,,ATRIB(1).EQ.12,UIP2;
        ACT,,ATRIB(1).EQ.13.AND.XX(74).EQ.1,UIP4;
        ACT,,ATRIB(1).EQ.13,UIP1;
        ACT,,ATRIB(1).EQ.14.AND.XX(75).EQ.1,UIP5;
        ACT,,ATRIB(1).EQ.14,UIP2;
        ACT,,ATRIB(1).EQ.15.AND.XX(76).EQ.1,UIP5;
        ACT,,ATRIB(1).EQ.15,UIP2;
;
;       COLLECT DAYS COMPLETED
;
UCOL    ASSIGN,XX(17)=XX(17)+1,XX(18)=TNOW-ATRIB(2)+5,
                XX(19)=TNOW-27*XX(16);
        COLCT,XX(18),REQUIRED DAYS;
        GOON,1;
        ACT,,XX(17).EQ.XX(3),UNOCL;    IF ALL UIP COMPLETED
        ACT;                           ELSE
        TERM,8;
;
UNOCL COLCT,XX(18),CLASS COMPLETE DAYS;
        ASSIGN,XX(17)=0,XX(18)=0,XX(19)=0;
        TERM;
;
;
;***** UIP MISSION TYPE 1 *****
;  2 UIP, 1 IP, 1 F16C, 1 F16D
;
UIP1    ASSIGN,ATRIB(5)=11,ATRIB(6)=0,1;
        ACT,,XX(20).EQ.0,FUI1;
        ACT,,XX(20).EQ.1,SUI1;
FUI1    ASSIGN,XX(20)=1;
        ACT,,,QSEV;
SUI1    ASSIGN,XX(20)=0;
        ACT,,,QEIG;
QSEV    QUEUE(17),,,,MT11;
QEIG    QUEUE(18),,,,MT11;
MT11    MATCH,1,QSEV/MAE,QEIG/MAE;
MAE     ACCUM,2,2,LAST;
```

```
       AWAIT(1),IP;
       ACT,1.5/24;
       AWAIT(2),F16C;
       AWAIT(3),F16D;
UI1PF  GOON,1;
       ACT,.5/24,XX(31)*XX(32),BRC1;
       ACT,.5/24,XX(31)*XX(32),BRD1;
       ACT,.5/24,XX(31)*XX(31),BC1D1;
       ACT,.5/24,XX(32)*XX(32);
       GOON,1;
       ACT,,NNGAT(WX).EQ.1.OR.NNGAT(DAY).EQ.1,WA11;
       ACT,.49/24;
       AWAIT(4),AREA;
       ASSIGN,ATRIB(6)=1,1;
       ACT,,XX(33)*XX(34),BRC1;
       ACT,,XX(33)*XX(34),BRD1;
       ACT,,XX(33)*XX(33),BC1D1;
       ACT,1.28/24,XX(34)*XX(34);
       FREE,AREA;
       ACT,,,PSC4;
       ACT,1/24;
       FREE,IP;
       ACT;
       ACT;
       GOON,1;
       ACT,1/24,XX(80),UCONT;
       ACT;
       GOON,1;
       ACT/66,,ATRIB(1).EQ.2,UA3P;
       ACT/67,,ATRIB(1).EQ.3,UA4P;
       ACT/68,,ATRIB(1).EQ.4,UA5P;
       ACT/69,,ATRIB(1).EQ.5,UA6P;
       ACT/70,,ATRIB(1).EQ.9,U10P;
       ACT/71,,ATRIB(1).EQ.10,U11P;
       ACT/72,,ATRIB(1).EQ.13,U14P;
UA3P   ASSIGN,ATRIB(1)=3,ATRIB(7)=1;
       ACT,1/24,,UCONT;
UA4P   ASSIGN,ATRIB(1)=4,ATRIB(7)=1;
       ACT,1/24,,UCONT;
UA5P   ASSIGN,ATRIB(1)=5,ATRIB(7)=1;
       ACT,1/24,,UCONT;
UA6P   ASSIGN,ATRIB(1)=6,ATRIB(7)=1;
       ACT,1/24,,UCONT;
U10P   ASSIGN,ATRIB(1)=10,ATRIB(7)=1;
       ACT,1/24,,UCONT;
U11P   ASSIGN,ATRIB(1)=11,ATRIB(7)=1;
       ACT,1/24,,UCONT;
U14P   ASSIGN,ATRIB(1)=14,ATRIB(7)=1;
       ACT,1/24,,UCONT;
;
;***** UIP MISSION TYPE 2 *****
;      2 UIP, 2 IP, 2 F16D
```

```
;
UIP2   ASSIGN,ATRIB(5)=12,ATRIB(6)=0;
       ACT,,,GTY3;
;
GUI2   GOON,1;
       ACT,1/24,XX(80),UCONT;
       ACT;
       GOON,1;
       ACT/73,,ATRIB(1).EQ.0,UA1P;
       ACT/74,,ATRIB(1).EQ.1,UA2P;
       ACT/75,,ATRIB(1).EQ.11,U12P;
       ACT/76,,ATRIB(1).EQ.12,U13P;
       ACT/77,,ATRIB(1).EQ.14,U15P;
       ACT/78,,ATRIB(1).EQ.15,U16P;
UA1P   ASSIGN,ATRIB(1)=1,ATRIB(7)=1;
       ACT,1/24,,UCONT;
UA2P   ASSIGN,ATRIB(1)=2,ATRIB(7)=1;
       ACT,1/24,,UCONT;
U12P   ASSIGN,ATRIB(1)=12,ATRIB(7)=1;
       ACT,1/24,,UCONT;
U13P   ASSIGN,ATRIB(1)=13,ATRIB(7)=1;
       ACT,1/24,,UCONT;
U15P   ASSIGN,ATRIB(1)=15,ATRIB(7)=1;
       ACT,1/24,,UCONT;
U16P   ASSIGN,ATRIB(1)=16,ATRIB(7)=1;
       ACT,1/24,,UCONT;
;
;***** UIP MISSION TYPE 3 *****
;  2 UIP, 2 IP, 2 F16C, 1 F16D
;
UIP3   ASSIGN,ATRIB(5)=13,ATRIB(6)=0;
       ACT,,,GTY6;
;
GUI3   GOON,1;
       ACT,1/24,XX(80),UCONT;
       ACT;
       GOON,1;
       ACT/79,,ATRIB(1).EQ.6,UA7P;
       ACT/80,,ATRIB(1).EQ.7,UA8P;
       ACT/81,,ATRIB(1).EQ.8,UA9P;
UA7P   ASSIGN,ATRIB(1)=7,ATRIB(7)=1;
       ACT,1/24,,UCONT;
UA8P   ASSIGN,ATRIB(1)=8,ATRIB(7)=1;
       ACT,1/24,,UCONT;
UA9P   ASSIGN,ATRIB(1)=9,ATRIB(7)=1;
       ACT,1/24,,UCONT;
;
;*****  UIP MISSION TYPE 4  *****
;   1 UIP, 2 IP, 1 F16C, 1 F16D
;
UIP4   ASSIGN,ATRIB(5)=14,ATRIB(6)=0;
       ACT,,,GTY4;
```

```
;
GUI4    GOON,1;
        ACT,1/24,XX(80),UCONT;
        ACT;
        GOON,1;
        ACT/82,,ATRIB(1).EQ.2,UA3S;
        ACT/83,,ATRIB(1).EQ.3,UA4S;
        ACT/84,,ATRIB(1).EQ.4,UA5S;
        ACT/85,,ATRIB(1).EQ.5,UA6S;
        ACT/86,,ATRIB(1).EQ.9,U10S;
        ACT/87,,ATRIB(1).EQ.10,U11S;
        ACT/88,,ATRIB(1).EQ.13,U14S;
UA3S    ASSIGN,ATRIB(1)=3,ATRIB(7)=1;
        ACT,1/24,,UCONT;
UA4S    ASSIGN,ATRIB(1)=4,ATRIB(7)=1;
        ACT,1/24,,UCONT;
UA5S    ASSIGN,ATRIB(1)=5,ATRIB(7)=1;
        ACT,1/24,,UCONT;
UA6S    ASSIGN,ATRIB(1)=6,ATRIB(7)=1;
        ACT,1/24,,UCONT;
U10S    ASSIGN,ATRIB(1)=10,ATRIB(7)=1;
        ACT,1/24,,UCONT;
U11S    ASSIGN,ATRIB(1)=11,ATRIB(7)=1;
        ACT,1/24,,UCONT;
U14S    ASSIGN,ATRIB(1)=14,ATRIB(7)=1;
        ACT,1/24,,UCONT;
;
; ***** UIP MISSION TYPE 5 *****
;       1 UIP, 2 IP, 2 F16D
;
UIP5    ASSIGN,ATRIB(5)=15,ATRIB(6)=0;
        ACT,,,GTY8;
;
GUI5    GOON,1;
        ACT,1/24,XX(80),UCONT;
        ACT;
        GOON,1;
        ACT/89,,ATRIB(1).EQ.0,UA1S;
        ACT/90,,ATRIB(1).EQ.1,UA2S;
        ACT/91,,ATRIB(1).EQ.6,UA7S;
        ACT/92,,ATRIB(1).EQ.7,UA8S;
        ACT/93,,ATRIB(1).EQ.8,UA9S;
        ACT/94,,ATRIB(1).EQ.11,U12S;
        ACT/95,,ATRIB(1).EQ.12,U13S;
        ACT/96,,ATRIB(1).EQ.14,U15S;
        ACT/97,,ATRIB(1).EQ.15,U16S;
UA1S    ASSIGN,ATRIB(1)=1,ATRIB(7)=1;
        ACT,1/24,,UCONT;
UA2S    ASSIGN,ATRIB(1)=2,ATRIB(7)=1;
        ACT,1/24,,UCONT;
UA7S    ASSIGN,ATRIB(1)=7,ATRIB(7)=1;
        ACT,1/24,,UCONT;
```

```
UA8S   ASSIGN,ATRIB(1)=8,ATRIB(7)=1;
       ACT,1/24,,UCONT;
UA9S   ASSIGN,ATRIB(1)=9,ATRIB(7)=1;
       ACT,1/24,,UCONT;
U12S   ASSIGN,ATRIB(1)=12,ATRIB(7)=1;
       ACT,1/24,,UCONT;
U13S   ASSIGN,ATRIB(1)=13,ATRIB(7)=1;
       ACT,1/24,,UCONT;
U15S   ASSIGN,ATRIB(1)=15,ATRIB(7)=1;
       ACT,1/24,,UCONT;
U16S   ASSIGN,ATRIB(1)=16,ATRIB(7)=1;
       ACT,1/24,,UCONT;
;
;
;
       ENDNETWORK;
INIT,Ø,6ØØ;
SIMULATE;
FIN;
```

Appendix G. F-16 Pilot Training Model (FORTRAN Code)

```
      PROGRAM MAIN
      DIMENSION NSET(100000)
      COMMON/SCOM1/ATRIB(100),DD(100),DDL(100),DTNOW,II
     1,MFA,MSTOP,NCLN,NCRDR,NPRNT,NNRUN,NNSET,NTAPE
     1,SS(100),SSL(100),TNEXT,TNOW,XX(100)
      COMMON QSET(100000)
      EQUIVALENCE (NSET(1),QSET(1))
      NNSET=100000
      NCRDR=5
      NPRNT=6
      NTAPE=7
      CALL SLAM
      STOP
      END
*
*   THIS EVENT SUBROUTINE RELEASES SP WAITING FOR ANOTHER SP
*   IN MSN TYPE 3 IF THE NIGHT COMES
*
      SUBROUTINE EVENT(I)
      COMMON/SCOM1/ATRIB(100),DD(100),DDL(100),DTNOW,II
     1,MFA,MSTOP,NCLNR,NCRDR,NPRNT,NNRUN,NNSET,NTAPE
     1,SS(100),SSL(100),TNEXT,TNOW,XX(100)
      IF (NNQ(11).EQ.0) GO TO 20
        DO 15 I=NNQ(11),1,-1
          CALL RMOVE(I,11,ATRIB)
          IF (ATRIB(5).EQ.3) THEN
            CALL FILEM(6,ATRIB)
          ELSE
            CALL FILEM(8,ATRIB)
          ENDIF
   15   CONTINUE
   20 IF (NNQ(12).EQ.0) GO TO 30
        DO 25 I=NNQ(12),1,-1
          CALL RMOVE(I,12,ATRIB)
          IF (ATRIB(5).EQ.3) THEN
            CALL FILEM(6,ATRIB)
          ELSE
            CALL FILEM(8,ATRIB)
          ENDIF
   25   CONTINUE
   30 IF (NNQ(13).EQ.0) GO TO 40
        DO 35 I=NNQ(13),1,-1
          CALL RMOVE(I,13,ATRIB)
          IF (ATRIB(5).EQ.6) THEN
            CALL FILEM(6,ATRIB)
          ELSE
            CALL FILEM(8,ATRIB)
          ENDIF
   35   CONTINUE
   40 IF (NNQ(14).EQ.0) GO TO 50
```

```
      DO 45 I=NNQ(14),1,-1
        CALL RMOVE(I,14,ATRIB)
        IF (ATRIB(5).EQ.6) THEN
          CALL FILEM(6,ATRIB)
        ELSE
          CALL FILEM(8,ATRIB)
        ENDIF
45    CONTINUE
50 IF (NNQ(15).EQ.0) GO TO 60
      DO 55 I=NNQ(15),1,-1
        CALL RMOVE(I,15,ATRIB)
        CALL FILEM(6,ATRIB)
55    CONTINUE
60 IF (NNQ(16).EQ.0) GO TO 70
      DO 65 I=NNQ(16),1,-1
        CALL RMOVE(I,16,ATRIB)
        CALL FILEM(6,ATRIB)
65    CONTINUE
70 IF (NNQ(17).EQ.0) GO TO 80
      DO 75 I=NNQ(17),1,-1
        CALL RMOVE(I,17,ATRIB)
        CALL FILEM(8,ATRIB)
75    CONTINUE
80 IF (NNQ(18).EQ.0) GO TO 90
      DO 85 I=NNQ(18),1,-1
        CALL RMOVE(I,18,ATRIB)
        CALL FILEM(8,ATRIB)
85    CONTINUE
90 IF (NNQ(1).EQ.0) RETURN
      DO 95 I=NNQ(1),1,-1
        CALL RMOVE(I,1,ATRIB)
        IF (ATRIB(9).EQ.1) THEN
          IF (ATRIB(5).EQ.3.OR.ATRIB(5).EQ.6.OR.ATRIB(5)
     1         .EQ.7) THEN
            CALL FILEM(6,ATRIB)
            CALL FILEM(6,ATRIB)
          ELSE
            CALL FILEM(6,ATRIB)
          ENDIF
        ELSE
          IF (ATRIB(5).EQ.11.OR.ATRIB(5).EQ.12.OR.ATRIB(5)
     1         .EQ.13) THEN
            CALL FILEM(8,ATRIB)
            CALL FILEM(8,ATRIB)
          ELSE
            CALL FILEM(8,ATRIB)
          ENDIF
        ENDIF
95    CONTINUE
   RETURN
   END
*
```

```
*     DEFINE PROBABILITY DISTRIBUTION & CALENDAR
*
      FUNCTION USERF(I)
      COMMON/SCOM1/ATRIB(100),DD(100),DDL(100),DTNOW,II
     1,MFA,MSTOP,NCLNR,NCRDR,NPRNT,NNRUN,NNSET,NTAPE,SS(100)
     1,SSL(100),TNEXT,TNOW,XX(100)
      REAL USERF,X
      INTEGER I,Y
*
      GO TO (1,1,1,4,5),I
*
*     DEEFINE CALENDAR SEASON USING 275 WORKING DAYS
*     AUTUMN=1, WINTER=2, SPRING=3, SUMMER=4
*
    1 X=TNOW-INT(TNOW/275.)*275.
      IF (X.GE.0..AND.X.LE.69.) THEN
        Y=1
      ELSEIF (X.GT.69..AND.X.LE.138.) THEN
        Y=2
      ELSEIF (X.GT.138..AND.X.LE.207.) THEN
        Y=3
      ELSE
        Y=4
      ENDIF
      GO TO (1,2,3),I
*
*     WEATHER CANCELLATION RATE
*
    2 IF (Y.EQ.1) THEN
        USERF=RNORM(.1567,.0640,1)
      ELSEIF (Y.EQ.2) THEN
        USERF=RNORM(.1513,.0711,2)
      ELSEIF (Y.EQ.3) THEN
        USERF=RNORM(.1327,.0246,3)
      ELSE
        USERF=RNORM(.2027,.0750,4)
      ENDIF
      IF (USERF.LE.0.) THEN
        GO TO 2
      ENDIF
      RETURN
*
*     DAY-LIGHT HOURS
*
    3 IF (Y.EQ.1) THEN
        USERF=UNFRM(.479,.52,5)
      ELSEIF (Y.EQ.2) THEN
        USERF=.43
      ELSEIF (Y.EQ.3) THEN
        USERF=UNFRM(.443,.515,7)
      ELSE
        USERF=.57
```

```
      ENDIF
      IF (USERF.LE.0.) THEN
        GO TO 3
      ENDIF
      RETURN
      END
```

Appendix H. Statistical Analysis Program (BMDP Program)

```
/ PROBLEM      TITLE IS 'ANALYSIS OF EXPERIMENTAL DESIGN.'.
/ INPUT        VARIABLES ARE 8.
               FORMAT IS '(1I2,1F6.1,2F5.1,4I2)'.
/ VARIABLES    NAMES ARE IDNO,TOTCOM,TXCOM,UIPCOM,NOSP,F16C,
                     F16D,ACFR.
               USE = TOTCOM,TXCOM,UIPCOM,NOSP,F16C,F16D,ACFR.
/ BETWEEN      FACTORS ARE NOSP,F16C,F16D,ACFR.
               CODES (1) ARE 1,2.
               NAMES (1) ARE NOSP6,NOSP7.
               CODES (2) ARE 1,2.
               NAMES (2) ARE F16C2,F16C3.
               CODES (3) ARE 1,2.
               NAMES (3) ARE F16D6,F16D5.
               CODES (4) ARE 1,2.
               NAMES (4) ARE LOFR,HIFR.
/ WEIGHT       BETWEEN ARE EQUAL.
/ END.
```

VITA

Major Young Jong, Lee, ROKAF was born on 10 December 1954 in Kangneung city, Korea. Upon graduating from Kangneung High School in 1972, he attended the Republic of Korea Air Force Academy in Seoul, Korea. In 1976, he graduated from the Air Force Academy with a Bachelor of Science degree in Electrical Engineering. After earning his aviator rating in 1977, he was assigned as a F-5E/F fighter pilot and served for two years. His next assignment was to Air Training Command as a A-37 instructor pilot in Undergraduate Pilot Training, where he trained undergraduate pilots for three years. In 1982, he was assigned to Suwon Air Base as an F-5E/F fighter pilot. In 1983, he moved to the Air Operation Center at HQ ROKAF and became a liaison officer between the ROKAF and the Presidential Security Force in the Blue House. In June 1984, he entered the School of Engineering at the United States Air Force Institute of Technology in the Graduate Operations Research Program.

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